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CANDLE-NUT AND CHINESE WOOD OIL TREES.

By W. N. Sands.

THE Department of Agriculture has received enquiries from time to time from local planters who were desirous of obtaining information concerning the possibility of cultivating successfully in Malaya the Candlenut and Chinese Wood Oil Trees.

As so much confusion exists in the botanical and chemical literature concerning these trees and the oils produced by them, it is thought that the following information derived from the publications named at the end of this article and from notes made on the species growing locally, may be useful for reference purposes.

The genus *Aleurites* to which all the trees belong is included in the Natural Order: *Euphorbiaceae.* There are five species of economic value namely, *Aleurites triloba, Forst*; *A. Fordii, Hemsl.*; *A. montana, Wils.*; *A. cordata, R. Br.*, and *A. trisperma, Blanco.* The synonymy of certain of these is too long for inclusion here, but the chief synonyms are included in the detailed description of each tree given below.

1. *Aleurites triloba, Forst*: (*syn. A. moluccana, Willd*) = Candlenut, Indian Walnut, Kemiri Nut, Kekuna Nut, Merikin Nut, Buah Keras, Lumbang and Country Walnut Oil Tree.

This species is native of Malaya and Polynesia. It has been widely distributed and is now naturalized in most tropical countries. Locally the tree occurs principally in the coastal districts of Pahang. It has also been planted on a small scale on two or three estates and there are indications that the tree will grow and fruit well under plantation conditions.

The tree is evergreen and reaches a height of 40 to 60 feet. The shoots and leaf-stalks are covered with short stellate downy hairs. The leaves are alternate with long petioles and vary considerably in shape. The younger leaves and those on vigorous shoots are palmately three to seven lobed with a broad open base, whereas the leaves on fruiting branches of older trees are usually much smaller, quite entire and ovate to lanceolate in shape.

The inflorescence is cymose and much branched with small flowers on short stalks. The sepals are velvety usually splitting into three lobes or segments. The five petals are white and bearded within. The stamens which number 15 to 20 are borne on a hairy receptacle and have short hairy filaments.

The fruit is sub-globose, 2-2½ inches in diameter, smooth, olive-coloured and shortly pointed. The husk is thin, fleshy, soft and encloses 1 to 2 large seeds each about 1¼ inches long and 1⅛ inches broad with a thick very hard and roughly furrowed seed-coat. The fruit matures in about six months after the opening of the flower.

The tree usually starts to flower, under suitable conditions, in three to four years from the time of planting.

The kernel of the nut contains 50 to 60% of oil which is used by the natives for illuminating purposes, hence the name 'Candle-nut.' The oil is allied in composition to Chinese Wood Oils, but is not as good as these in quality, and like them is inferior to linseed oil when used in paints and varnishes.

The oil is not edible, and further, the meal derived from the kernels after the oil has been extracted has strong purgative properties.

2. *Aleurites Fordii. Hemsl.* (*syn. A. cordata. Muell., Dryandra oleifera, Wall., Elaeococca verrucosa Adr. Juss.*) Chinese Wood Oil. Tung-yu (Tung Oil Tree).

The habitat of this tree is in the warm temperate parts of China, more especially the water-shed of the Yang-tze River. It also occurs in Fokien and Yunnan. It is a quick growing, much branched short-lived tree, and seldom exceeds 30 feet in height. It is highly ornamental when in flower.

Frequent attempts have been made to cultivate this valuable species at low elevations in the tropics, but as far as is known no success has been recorded. It is said to have been successfully acclimatized in the Southern Shan States between 1,500 to 2,000 feet altitude, and to some extent in Burma, Assam, Nepal and Sikkim. The tree also thrives in the Southern United States of America. A small area has recently been planted with this species on an estate in Negri Sembilan, but judging from previous experiments with this tree it is not likely to grow well in Malaya at elevations below 2,000 feet.

The leaves are deciduous, dark glossy green, broadly ovated, heart-shaped and long pointed. The blade of the leaf is 4 to 6 inches or more long and broad. The leaf stalk is about 6 inches long. On young trees and vigorous, but usually sterile shoots, the leaves are three-lobed.

The inflorescences are terminal and axillary, much branched and form at the end of each shoot a loose rounded mass.

The flowers are 1 to $1\frac{1}{2}$ inches wide, white tinged with pink and yellow markings more especially near the base.

The fruit is green passing to dull brown when ripe. In shape it is flattened, rounded and somewhat top-shaped, $1\frac{1}{2}$ to 2 inches long and broad with a short stout point at the summit. The husk which is thin and opens from the base upwards encloses from three to five, rarely more, compressed broadly obovoid seeds each $\frac{3}{4}$ to 1 inch long and broad, very slightly ridged and warty on the surface and with a thin shell.

Although the fruit opens naturally it is rarely allowed to do so by the Chinese who collect it before it is ripe and allow it to ferment in grass or straw covered heaps. The husk being thin, it is easily destroyed by fermentation in these heaps and the seed is readily removed.

In the Shan States the tree comes into bearing in 8 to 10 years from the time of planting.

In China it is the best oil producing species. It is estimated that nine-tenths of the wood-oil exported from that country is derived from it; moreover, the oil is especially valuable for use in paints and varnishes although not superior to linseed oil.

Both the fruit and seed are poisonous to man and cause vomiting and purging when ingested.

3. *Aleurites montana, Wils. (syn. A. cordata, R. Br., Dryandra oleifera, Lam.)* Chinese Wood Oil, Mu-yu Shu. (Wood Oil Tree).

This tree is found in the South-eastern parts of China from the province of Fokien southward to Tonking. It requires a sub-tropical climate and a more abundant rainfall than the northern species *A. Fordii.* The tree is said to resemble closely in size, habit, foliage and general appearance, but not in its flowers and fruit, the Tung-yu Shu (*A. Fordii.*)

In the Kuala Lumpur Experimental Plantation there are two plots of *A. montana*, now $3\frac{1}{2}$ years old, which were derived from seed obtained from Hong-Kong. The trees have made strong healthy growth although planted on a steep hillside in poor sandy soil. Some of these are now from 12 to 15 feet high, but all the leaves are still deeply palmately five-lobed and in this respect are quite distinct from juvenile leaves of *A. Fordii.**

It is evident that the species can withstand a much warmer climate than *A. Fordii.* and it gives indications of thriving as well in Malaya as the local species, *A. triloba.*

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* Towards the end of December, and since the above was written, several trees of *Aleurites montana* in the Kuala Lumpur Plantation started to flower. The flowers are white, $1\frac{1}{2}$ inches in diameter, and are borne in large terminal showy masses. Most of the leaves of the flowering shoots are quite entire and heart-shaped, but some of them are three to four-lobed.

The inflorescence consists of a terminal corymb or a raceme and is produced on shoots of the current season's growth after the leaves have fully expanded. The male inflorescence is many flowered, much branched, 6 to 8 inches long and 8 to 12 inches broad. The female inflorescence is racemose, relatively few flowered, and only 3 to 4 inches long.

The fruit is egg-shaped, $1\frac{3}{4}$ to 2 inches long and $1\frac{1}{3}$ to $1\frac{3}{4}$ inches broad. It is pointed at the summit and flattened at the base. There are three prominent longitudinal and several transverse raised ridges on it. The husk of the fruit is hard and woody and usually encloses three compressed, broadly ovoid, seeds each about $1^1/_5$ inches long, 1 inch wide and warty on the outside. The fruit opens from the base upwards into three parts so that the seeds can be easily extracted. Since the husk of the fruit is hard and comparatively thick, it is not easily destroyed by fermentation as is the case with the Tung-yu fruit derived from *A. Fordii.*

The oil is said to be similar in composition and value to that derived from the Tung-yu seed; but the exports of it are small. Owing to the botanical confusion which has existed, the oil has not been clearly distinguished from the oils obtained from the Tung-yu (*A. Fordii.*) and the Japanese species, *A. cordata.*

4. *Aleurites cordata, R. Br.* (*syn. Dryandra cordata, Thunb. D. oleifera, Lam.* and *Aleurites japonica, Blum.*) Japanese Wood Oil. Abura Giri, Abrasin.

This species occurs in Southern Japan and has been confused with the Chinese species. It is similar in size, habit and foliage to the Mu-yu (*A. montana, Wils.*) Like that tree it produces its flowers at the end of the current season's growth after the leaves are fully expanded. The leaves on flowering branches are often three-lobed.

The inflorescence is an erect cymose panicle and there is a decided tendency towards separate male and female panicles, but these are produced on shoots growing close together on the same branch. The flowers are rather smaller than those of *A. montana.*

The fruit is rounded somewhat top-shaped and three-angled. It is about $\frac{1}{2}$ inch long and $\frac{3}{4}$ inch wide, flattened and slightly depressed at the summit. It tapers slightly to the stalk and possesses three small longitudinal ridges and several small irregular transverse ones. The husk is thin, soft and fibrous and encloses 3 to 5 seeds which are smooth, compressed, sub-globose and about $\frac{1}{2}$ inch long and broad. The fruit and seed are therefore much smaller and quite distinct from any other species.

The oil is not an article of regular export to Western countries, but is used chiefly by the Japanese as an illuminant. It is similar in composition to Candle-nut oil and could probably be used for similar purposes.

5. *Aleurites trisperma, Blanco.* (*syn. A. saponaria, Blanco*)—Balucanag, Balucanah, Calumban.

This tree like *A. triloba* is a tropical species found in the Philippine Islands, but not, as far as is known, in a truly wild state.

Unlike the previous species described, the leaves of this tree are quite entire in all stages of growth, heart-shaped, pointed and glabrous.

The flowers are smaller than those of *A. Fordii* and *A. montana* but the fruit is larger. In shape the fruit resembles that of *A. montana* being oval and pointed about 2½ inches long and nearly as broad. The husk is thick, hard and somewhat rough on the surface. The seed is large, smooth, oval to round in shape, up to 1¼ inches long and almost as broad; it is slightly flattened and compressed along the inner side. The shell is thin and brittle.

The oil from the seed is said to be poisonous but to possess good drying properties.

Aleurites oils, other than those from the two Chinese species, are not well known in Western markets, but if these were exported in quantity at regular intervals, manufacturers of soft-soap, oil varnishes, paints and other articles such as linoleum, would no doubt become interested in them. It would appear, however, that the demand for and market value of them will always be regulated by the supply and price of linseed oil to which all are somewhat inferior.

It is hoped that the above notes on the different species of Aleurites will assist those who are interested in them to identify them.

The plates numbered 1 and 2 show the chief characters of the fruit and seed of each tree at approximately natural size.

Mr. E. H. Wilson of the Arnold Arboretum kindly supplied the specimens of the fruit, and seed of *Aleurites Fordii*, *A. montana*, and *A. cordata*, whilst fruit, seed and leaves of *A. trisperma* were supplied by the Director of Agriculture, Manila, Philippine Islands. Our thanks are also due to Mr. W. Popenoe, Agricultural Explorer of the United States Department of Agriculture, for a valuable collection of photos of growing trees, fruit and seed of all the species.

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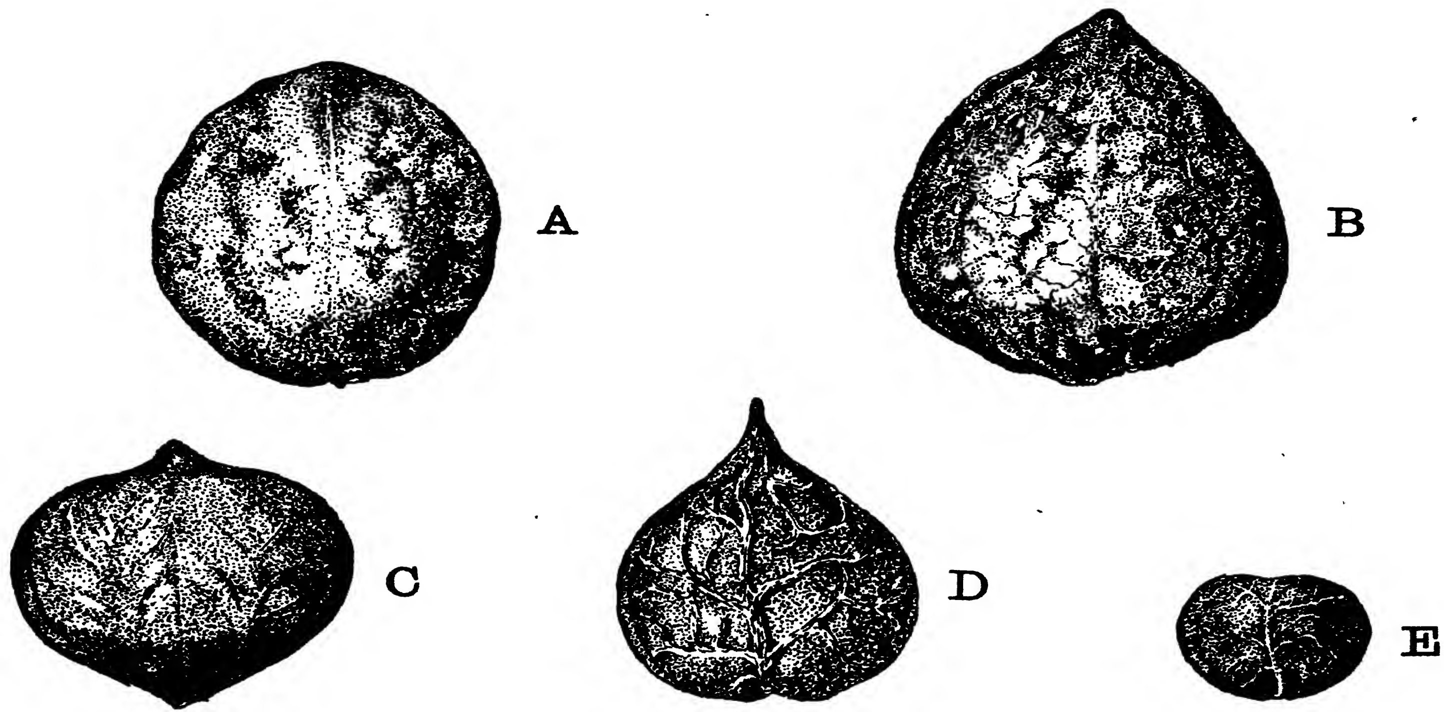


Plate I. — Fruit of Aleurites. — A. A. triloba; B. A. trisperma; C. A. Fordii; D. A. montana; E. A. cordata.

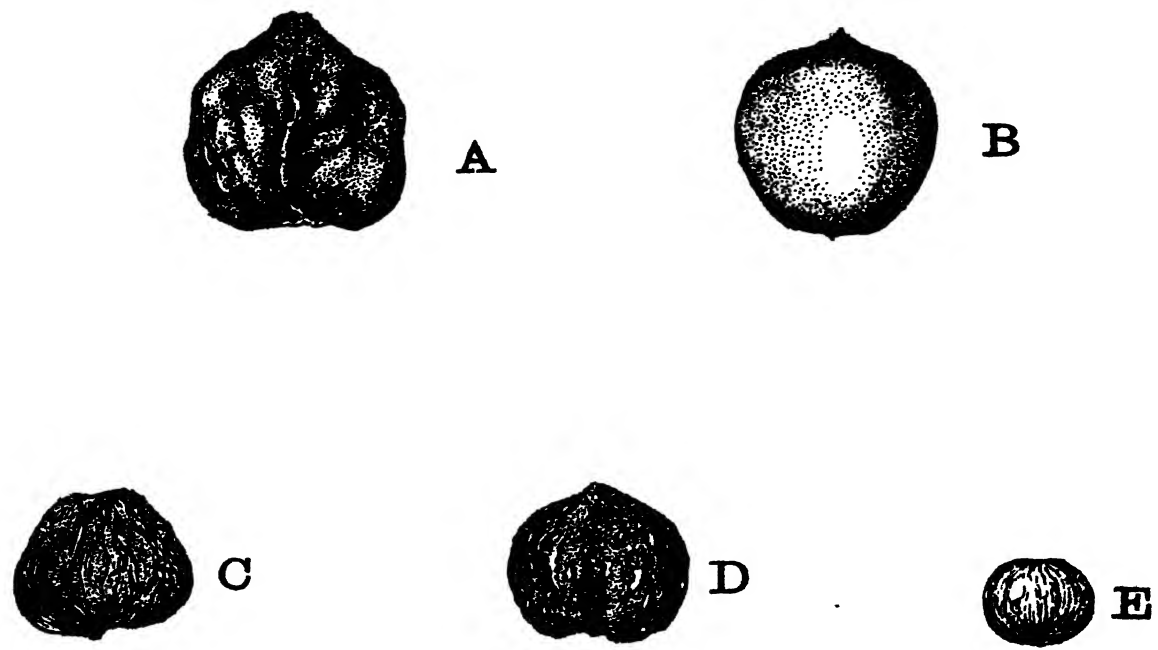


Plate II. — Seed of Aleurites. — A. A. trilobа; B. A. trisperma; C. A. Fordii; D. A. montana; E. A. cordata.

THE UTILISATION OF CITRONELLA GRASS PLANTED AS A PREVENTIVE OF SOIL WASH.

By C. D. V. Georgi.

CITRONELLA grass is frequently planted on hilly land as a preventive against soil wash and as this grass contains an essential oil (Citronella oil) for which there is a constant demand, many estates have considered recently the possibility of utilising such grass for the preparation of the oil.

Several determinations of the oil content of grass from such estates have been carried out, while, in addition, a considerable quantity of the oil from the grass growing under similar conditions on Government Plantations, has been prepared and sold on the London market. It is thought therefore that the publication of the results of these investigations will be of interest.

Varieties of Grass.

Citronella grass belongs to the genus Cymbopogon (Natural order Gramineae) to which natural order certain other so called aromatic grasses belong, such as Lemon grass, Palmarosa grass and Ginger grass, all of which are similarly distilled for their essential oils. Although botanically there are doubtless several varieties of this grass, from the cultivation point of view there are only two, namely *Cymbopogon Nardus*, Rendle, known as *lena-batu* and *Cymbopogon Winterianus*, Jowitt, known as *Maha Pengiri*.

The former variety Cymbopogon Nardus, Rendle, occurs chiefly in Ceylon, while *Cymbopogon Winterianus*, Jowitt, which yields the so-called Java Citronella oil, would appear to be the variety common in this country.

Cultivation of Grass.

Citronella requires a hot damp climate and therefore grows well in this country, but it must be remembered that, if the grass is to be cultivated both as a preventive against soil wash and as an economic crop, it will require more attention than is usual at present, where it serves only the former purpose.

The grass should be cut at least twice a year, it should never be allowed to flower or become rank, since the oil content is greatest in the young leaves. The stalks contain practically no oil. Care should be taken to clear out the stumps after cutting so as to allow free growth for leaves.

A light changkolling in order to ensure a certain amount of tilth, is also beneficial, while if possible, the exhausted grass (after extraction of the oil) or its ashes (after being burnt under the boiler) should be turned in round the plants.

This exhausted grass has a considerable fertilising value as the following table giving the results of analysis of a locally grown grass shows :

	Per cent.	Per cent (on dry).
Moisture	- 10.7	—
Ash	- 5.0	5.6
Organic and Volatile matter	- 84.3	94.4
Nitrogen	- 0.98	1.11
Potash (as K_2O)	- 1.10	1.23
Phosphoric Acid (as P_2O_5)	- 0.12	0.13

It has been noticed that the oil output diminishes with the age of the plant, so that a stage is reached when it is no longer profitable to extract the oil, and in countries where Citronella grass is cultivated solely for its oil content it is customary to replant fields about every ten years. In cases where this grass has been planted on terraces between young rubber this stage would be reached much earlier, probably in 5 to 7 years, as the shade afforded by the trees would affect the growth of grass considerably. Citronella grass will not thrive under heavy shade, it requires sun for its development.

Outline of Process for Extraction of Oil.

The process by which the oil is extracted from the grass is simple, it consists in a steam-distillation, that is to say, steam is passed through the grass when the oil is volatilised and carried over by the excess of steam. The mixed vapours are condensed, when the oil, being lighter than the water, rises to the surface and can be separated.

Preliminary treatment of Grass.

The grass is not distilled when freshly cut, but is allowed to dry for a few days. The oil content is not affected to any extent, provided that, during the period of drying, the grass is kept spread out. If the grass be piled, heating and fermentation will ensue, affecting both the quality and quantity of the oil.

The advantages to be gained by this preliminary drying are firstly, on account of reduction in volume on drying, a much larger equivalent quantity of grass can be packed into the still and secondly the diminution of the moisture content results in a considerable saving of fuel. Further, it has been noticed that, when distilling dried grass as compared with fresh grass, the oil seems to separate more easily from the water; when distilling fresh grass a certain quantity of gummy matter appears to pass over with the oil, which retards the separation.

With regard to the loss of moisture which Citronella grass undergoes during drying, experiments have shown that, drying under an attap shed and with normal weather conditions, the loss in weight after 4—5 days is between 60 and 65 per cent.

Extraction of Oil.

The site selected for the erection of the plant for extracting the oil must be close to a regular water supply, as the success of the operation depends to a very large extent upon the efficient condensation of the mixed oil and water vapours.

The plant required consists of three parts (*a*) a boiler for raising steam, (*b*) a still in which the dried grass is packed, (*c*) a condenser in which the mixed vapours of steam and oil are condensed.

The boiler is not required to work at high pressure, about 15 lbs. is sufficient as a working pressure. If high pressure steam is used it will be found that the grass becomes black and the oil is dark in colour. The still is usually made of cast iron and is provided with a perforated plate on which the grass is packed and through which the steam passes. The top of the still should be so arranged that it can be opened easily to admit of rapid emptying and filling. In some installations several small stills, all mounted on trunnions, are used in place of one large still in order to facilitate these operations. In that case all the stills are connected to the main steam pipe and the main condensing pipe. A cheap and effective condenser can be made by fixing a coil of tin pipe in a large barrel through which cold water circulates, or, for a small installation, the barrel may be replaced by a large oil drum.

As regards fuel, once the fire has been started it can be maintained by using as fuel the dried exhausted grass from previous distillations. In a series of experiments carried out recently it was found that in this way a reduction in the quantity of wood required could be effected up to between 50 to 60 per cent.

The time of distillation will depend upon several factors, such as the size of the still, and can only be determined as a result of experiment. In a series of experiments similar to those referred to in the previous paragraph it was found that, with a boiler steam pressure of between 15 to 20 lbs., the distillation of about 1 picul of dry grass was completed in about 1¼ hours.

It is important to see that the condenser is effective, so that the vapour of the oil remains in contact with steam for as short a time as possible. With efficient condensation the separation of the oil and water is rapid and can be effected mechanically in a Florence flask or, if this is not available, the mixture of oil and water can be run into a large container, the water being run off, leaving the oil behind.

After separation from the water, the oil requires no further treatment beyond filtration through thin blotting paper or a double thickness of fine muslin to remove any sediment, after which the oil is ready to pack into tins or drums for export. The colour of the oil varies from a yellow to a yellowish brown, due to the iron of the still. If the grass be treated in an enamel still or one lined with tin the oil is practically colourless.

Yield of Oil.

As a result of several determinations it appears that the average yield of oil on grass cut regularly is about 0.5 to 0.6 per cent by weight, that is, one ton of fresh grass gives 11 to 13 lbs. of oil. In some cases a yield of 0.8 per cent on the fresh grass has been obtained, but this figure is considered somewhat exceptional, while, as an example of the diminution in yield of oil if the grass be allowed to become rank, it may be stated that as a result of experiments made with grass which had not been cut for 18 months the yield of oil was found to be only 0.3 per cent by weight.

When planted as a sole crop the yield of fresh grass per acre appears to be about 5 tons, so that about 60 lbs. of oil per acre may be expected at each cutting.

Value of Oil.

Chemical analyses of oil distilled from local grass have shown that this is equal in quality to Java oil, as will be seen from the figures given in the following table:—

	Local oil.	Java oil (average).
Density (15.5°C) ...	0.8852	0.884 —0.900
Refractive index (20°C) ...	1.4678	1.4650—1.4720
Acetylisable content (calculated as Geraniol) ...	88.9%	85—96%
Miscibility with 80% Alcohol (Schimmel's test) ...	Miscible, but when diluted to 3 vols., slight opalescence.	Miscible, a slight opalescence is permitted.

Further, during the latter part of 1921 a large quantity of grass, planted as a preventive of soil wash on the Government Experimental Plantation at Batu Tiga, was collected and distilled, about 20 lbs. of oil being despatched for sale on the London Market. The oil when sold about the end of December 1921 realised 2/6 per lb. nett, the price then prevailing for Java oil. An extract from the buyer's letter is appended:

> " With reference to the small lot of Malay Citronella Oil, which you sold me the other day, I would say that this is an excellent quality, quite equal to the best Burmese oil, and if your people can continue to supply an equal quality, distilled in just the same way as these 20 lbs. were distilled, there is no reason why they should get any less money for it, than is generally obtained for good Burmese oil."

Since the date of that letter the price of such Citronella oil has appreciated steadily, until now it stands at about 4/- per lb.*

*The latest price (December 1923) is 4/8 — 4/9 per lb.

Conclusions.

The results of these investigations show that the extraction of the oil from the grass is a simple operation. The plant required is also comparatively inexpensive, and can be improvised easily. Further, with the oil standing at its present price and a supply of grass sufficient to maintain a still more or less continously in operation, there should be a fair margin of profit.

It is recommended however that as far as possible the plant be an improvised one, as it should be borne in mind that, when Citronella grass is planted as a soil wash preventive on hilly land, between say young rubber or other crops, which will eventually give shade, the yield of oil will begin to diminish after a few years, until a stage is reached when, owing to the increased shade, it will be no longer profitable to distil the grass. Under those conditions the estate will not be left with an expensive plant for disposal.

Received for publication July 16th, 1923.

A REVIVAL OF PATCHOULI CULTIVATION IN JOHORE.

By A. E. C. Doscas.

THE decline of Patchouli cultivation owing to over-production, and the increasing popularity of *Hevea brasiliensis*, removed from Johore for many years an industry which at one time was of considerable importance. Within the last few months however, a good deal of attention has been attracted towards the cultivation of this crop and there are indications of a gradual resuscitation of the industry.

Enquiries have lately been received from several sources, and its sporadic cultivation on a small scale led Mr. Low Ting Teng to instal in his pine-apple factory a small plant for the distillation of the oil. This combination, however, carried with it several obvious disadvantages, and Mr. Teh Kong Siow who is going in for cultivation on a large scale on his estate in Johore Bahru took over the plant, and had it erected on his property.

Patchouli (*Pogostemon patchouli*) is a small herbaceous plant, with flaccid leaves and stems, which on distillation yield an essential oil from which Essence-of-Patchouli is prepared. Patchouli perfume is popular in Europe and India, and is largely used in the preparation of other perfumes.

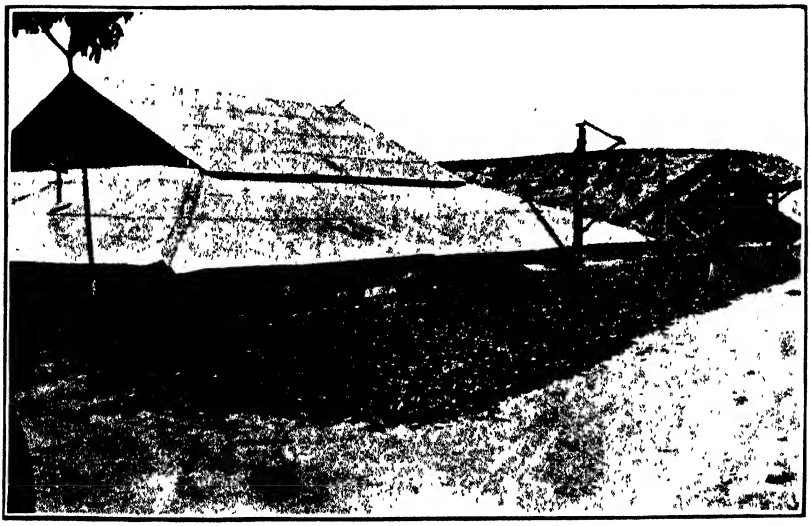
Propagation is carried out by means of cuttings, which are set out in nursery beds previously prepared. The young shoots require careful attention, a little shade, and plenty of water until properly established, when they may be planted out in the field.

Low, somewhat moist land, appears to give good results. The plants are set out in rows three feet apart, with about three feet separating each plant in the rows. In good soil growth is fairly rapid, the plants become very much branched, and usually attain a height of three feet. During the growing period the land requires constant weeding, and a little light cultivation is well repaid.

When fully grown, which is usually at about six months, the leaves and stalks are cut a little distance above the ground, tied into bundles, and removed to the drying ground near the storage sheds. Here they are spread out in a thin layer on a concrete bed or other hard dry surface, and allowed to become thoroughly sun-dried. The mass is constantly turned over by means of sticks to obtain even and thorough drying, and to prevent fermentation which would be extremely detrimental to the oil. When thoroughly dry the whole is stored preparatory to distillation.

Cultivated on good land, Patchouli may yield three cuttings (the first giving roughly ten pikuls of leaves per acre) before re-planting is

Cultivation of Patchouli.



Drying of Patchouli.

necessary. It is understood that subsequent plantings on the same land are accompanied by a marked deterioration in the crop. In the event of the industry showing any signs of becoming sufficiently profitable, investigations in crop rotation may be desirable.

In the matter of distillation, advantage is taken of the fact that the oil is volatile, and the dried matter of the plants is placed in a closed iron still holding about one and a half pikuls of material. Steam from a boiler is driven into the mass through a hole in the bottom of the still, and emerges through a pipe from the top and is led into a spiral coil pipe submerged in water where the steam charged with the vapour of the oil condenses and the whole runs off into a collecting vessel. From the bottom of this vessel an overflow pipe is taken to a point a little distance below the rim, and through this pipe the water from the bottom is led away leaving the oil in an impure state floating on the surface. Further distillation and refining is necessary before the oil is exported.

One pikul of dried material yields about two pounds of oil, the present price of which is seven to eight dollars per pound.

The plate opposite shows the plant in the field, and the leaves and stalks in the drying yard.

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NOTES.

AVOCADO OR ALLIGATOR PEAR.

The Avocado pear is little known in the Malay Peninsula. Many people who are familiar with it consider the fruit a great delicacy and it is to be hoped that the tree, which is well suited to Malayan conditions, will soon be more generally cultivated throughout the Peninsula. A few Europeans are growing it, but it is practically unknown to the Asiatic population of this country.

The common Avocado of America is a native of Mexico and Tropical America and is grown commercially in the West Indies, Brazil, California, the Philippine Islands, and several other tropical and sub-tropical countries. It is reported that this fruit takes the place of meat, to a certain extent in the dietary of the Central Americans and there is every reason to believe that eventually the Avocado will be as familiar to American housewives as the banana is to-day.

The tree belongs to the Natural Order Laurineae. There are many species and varieties of *Persea*. The tree cultivated here is a variety of *Persea gratissima, Gaertn.* which is synonymous with *P. americana Mill.* The tree reaches a height of about 25 to 30 feet in this country and has large pear shaped fruits. A considerable variation in the size of the fruits has been noticed which is no doubt due to soil conditions and soil treatment. The fruit grown locally is green in colour and is harvested one or two days before it is fully ripe when it should be stored in a cool dry place until it is slightly soft to the touch, then it is ready for consumption. The pulp is fairly firm when not over-ripe and of the consistency of fresh butter, hence the name 'Midshipman's butter' for the fruit in the West Indies. It is yellowish in colour with a delicate nutty flavour.

Seeds of the Avocado pear were received from Trinidad in October, 1909, and the seedlings planted at Kuala Lumpur and Batu Tiga Experimental Plantations in the early part of 1910. The trees grew extremely well and in the fifth year attained a height of about 20 feet when they commenced to bear fruit. The soil on which they are growing is a poor laterite one and given more favourable soil conditions there is no doubt whatever that the trees would reach maturity at an earlier age, would produce larger fruits and a heavier crop.

The Avocado may be easily raised from seed and the results obtained by the writer from this method of propagation are satisfactory, although in the commercial growing of this crop it is advisable to propagate the tree by budding or grafting in order that the fruit may be uniform in quality. Seed should be selected from the best trees yielding the largest and most uniform fruits. As the seeds retain their germinating power for a short period only it is essential to plant

them as soon as possible after the fruit has been consumed. A satisfactory method is to sow the seeds singly in bamboo pots which contain a light friable soil, care being taken to ensure that the pot has good drainage. The seeds are planted in such a way that the pointed end is level with the surface of the soil. The seedlings are kept under shade until ready for transplanting which takes place in from two to three months from the date of seed sowing. The seedlings transplant well, but it is recommended to provide a little shade until the plants have recovered from the operation. The distance of planting is about 20 by 20 feet. It would appear that the Avocado will thrive in a variety of soils but a rich friable loam will, in all probability, give the best returns. The tree responds well to cultivation and manuring. Light tillage around the trees should be carried out at intervals of six months and manuring with organic manure, once a year. On no account should lalang be allowed to grow in the orchard.

The Avocado can be grown successfully in the plains in this country and there is every reason to believe that it will thrive on the hills. Good growth has been obtained from a plant growing at Ginting Simpan at an elevation of over 2,000 feet. In Ceylon the tree is stated to thrive best at medium elevations.

At the Experimental Plantation, Kuala Lumpur, over 100 fruits have been obtained from 6 to 7 years old trees but as already stated this yield could no doubt be increased if grown on better quality soil.

The fruit may be consumed in a number of ways—as a dessert, a salad, in soup and ice-cream.

In the International Review of the Science and Practice of Agriculture, Vol. I, No. 2, April—June, 1923, page 407, it is reported in connection with Fruit Growing in Brazil that " The following species are to be recommended for industrial cultivation: the Avocado (*Persea gratissima*), a native of Brazil, where it reaches the height of 15 m. in the fifth year after sowing, and begins to bear when 5 or 6 years old. In the extreme north of Brazil, this tree produces two crops annually, and a fine specimen yields 600 to 700 fruits a year from its seventh year. The fruits can be kept in cold storage for over 30 days."

The following is an extract from the Report of Administrator for the year ending 30th June, 1922. The Parliament of the Commonwealth of Australia, Northern Territory. Annual Report of the Superintendent of Agriculture and Curator Botanic Gardens.

" *Fruits.*—Some Avocado pear trees (*Persea americana, Mill*) raised from seed obtained from the Philippine Department of Agriculture have been planted out, and are now well established, and giving every indication of health. This fruit has not previously been grown in the Northern Territory. It is of great importance, being a valuable food, and it is said to contain a higher protein content than any other fresh fruit. Its chief value, however, is due to its high content of fat.

In view of these facts it is gratifying to be able to report well on the growth of the trees to date, and efforts will be made to obtain more plants and further varieties."

Application for seedlings should be addressed to the Agriculturist, S.S. and F.M.S.

F.G.S. (5-12-23)

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(2) THE FLOWERING OF TUBA, *DERRIS ELLIPTICA*, BENTH.

It has often been a matter of comment that *Derris elliptica* is rarely seen to flower in the Malay Peninsula. As a young plant flowered recently at the Experimental Plantation, Serdang, it is thought worthy of record.

Derris elliptica is deciduous, losing the majority of its leaves during February and early March. In this instance the flowers were borne during the latter part of March, when the new foliage had begun to appear. The raceme is about seven inches long and covered with minute hairs. The individual flowers are pale rose-pink, turning to buff as they age, and about an inch long. The flowers soon fell and no seed was produced.

J.N.M. (9-4-23).

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(3) BULRUSH MILLET.

(*Pennisetum typhoideum*; Ekur Kuching (M), Kambu (T)).

Four small plots of this valuable foodstuff were planted at Kuala Kangsar during June. The results have been distinctly encouraging; the yields, so far as can be estimated, being well up to the Indian standard.

Unfortunately great damage was done to two of the plots by fowls, but the results obtained seem to indicate planting out from a nursery as the better method of cultivation.

No insect pests were observed and birds, with the exception of the fowls mentioned above, were kept away by pieces of cloth on bamboos.

The grain matured very uniformly in about 73 days from sowing. A further series of tests is now in progress.

J.M.H. (9-10-23).

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(4) GROUND-NUT CAKE FOR HORSES.

Trials of this cake as a horse-feed were carried out at Kuala Kangsar, with the kind co-operation of H.H. the Sultan of Perak, during July and August, 1923.

Mr. T. V. Welsh, who conducted the trials, found that the cake, obtained from Sweet Kamiri Estate, was very successful at the outset. It is easily powdered, an advantage over most cakes, can be intimately mixed with the ordinary feed, and is liked by the ponies. The first trial was carried out on a horse in poor condition that normally would have been put on condition-powders. The cake was fed at the rate of ½ lb. per feed in each of three feeds daily. In the course of two weeks the pony had improved very much, and was eating well-which had not previously been the case.

The next trial was made on four horses, but by this time the cake had lost its freshness and there was a suspicion of mouldiness, the results being less satisfactory.

It is thought that the mouldiness to which this cake is subject may be overcome by admixture with molasses, and it is hoped to carry out some experiments to this end.

In the meanwhile it is recommended that cake for feeding horses or cattle be bought in quantities sufficient for a week on ten days only, and should be guaranteed fresh when bought.

J.M.H. (27-9-23).

CATTLE BREEDING.*

By William Smith.

Imperial Dairy Expert.

[*Reprinted from "The Agricultural Journal of India," Vol. XVIII, Part VI.*]

I am aware that the Committee now sitting in Poona is one mainly concerned with cattle breeding as it specially affects the Presidency of Bombay, but I am sure the Committee will not object to my dealing with the matter from an all-India point of view and on general lines.

I think it is well in dealing with a subject like this to endeavour as far as possible to state—

(1) The present condition of the industry,

(2) Causes of existing condition, and

(3) Steps to be taken to improve existing conditions.

As regard (1), I have now been in India for sixteen and a half years during the whole of which time I have been in very close touch with the cattle breeding industry in the Punjab, the United Provinces, Central Provinces, Sind, Bombay and Madras, and it is my considered opinion that in these parts of the country the quality of the cattle has declined since I came to India, or to put it more definitely, I believe that, generally speaking, it is impossible in the open market to-day to procure in quantity, no matter what the price may be, as good draught bullocks and milch cows as were obtainable 16 years ago. Most certainly the quality of milch cattle available in India, except in the district of Sind, is very much worse than those available 16 years ago. If that be so, it behoves us to look for the reason for such a decline at a time that practically every other country in the world has been able to improve the quality of its cattle, and the root reason undoubtedly is want of knowledge, accentuated by many circumstances such as the spread of irrigation canals and conversion of forest lands with consequent diminution of grazing areas, the increased facilities for transport and consequent mixing of breeds or types, increased prices for human foodstuffs, and the deliberate and erroneous teaching by the departments responsible for cattle breeding that the development of dairying or milk production would injure the draught quality of working bullocks. I look upon it that the wilful elimination of milking qualities in the stud bulls issued by Government for breeding purposes and the persistent teaching of all concerned in cattle breeding for many years in India that dairying or heavy milking qualities of dams are injurious to the qualities of plough cattle have probably done more

* Note submitted to the Bombay Cattle Committee, 1922.

harm to cattle breeding in India than anything, because this elimination of milk-giving qualities strikes at the root of the whole industry. So little attempt has been made to develop milking quality of most breeds of Indian cows that the dams even of some of the finest breeds of cattle are unable to suckle their young within a reasonable time, which means later maturity and fewer calves during the lifetime of the dam.

In times past this did not matter so much, as great breeding areas were available which were useless for any other purpose, but these areas now grow cotton, or pulse, or wheat, and what must take their place. The ordinary cultivator must take their place, and to enable him to do this profitably he must have a cow which will give sufficient milk and ghi (clarified butter) for his family and at the same time rear a good draught bullock. As things are now, the cultivator in India keeps one or two or three cows which can hardly produce enough milk for their calves, and he keeps a female buffalo to give milk and ghi for his family. This female buffalo is quite unnecessary if the breeder can get a cow which will rear the calf and in addition provide the breeder with milk and ghi. Nothing is more certain than that the dam of any type or class of good working bullock whatever can and ought to be a first class milker. We hear many people say that the solution of the cattle breeding problem is to grow more fodder but that is putting the cart before the horse. What we want is fewer but more efficient cattle. No country in the world can afford to keep a cow which is only capable of suckling a calf. The enormous increase in the number of buffaloes in India is the cause of the fodder shortage, because not only is the female buffalo used because the cow is such an inefficient milker, but the male buffalo is often permitted to survive. This male is useless for draught in most parts of the country, and between the female buffalo used because the cow is not as good a milker as she might be and the useless male buffalo the country is drained of its fodder to such an extent that there is not sufficient for any class of cattle.

The solution of the whole matter lies in the dual purpose animal. No matter what class or type of male plough bullock is required, the dam must always be a good milker, and all bulls issued for stud purposes must be got from heavy milkers as well as be of the right size, type and class.

This country can produce all the draught cattle it needs, more than all the dairy produce it can consume from much fewer cattle than we now possess, but they must be more efficient cattle and they must be *dual purpose* every time. Any propaganda outside of *dual purpose* efficiency is only perpetuating a great economic evil. No other basis can be profitable.

If these are the reasons for the present state of affairs, then the first steps to remedy matters is dairy education. In every civilized country in the world to-day dairying occupies a very prominent position in its Agricultural Department. There is not, at the present moment, a single dairy school in India. The crying need of this country agriculturally is dairy education, both of the cultivator and

masses. Not only is the education of the men in the street necessary from the cattle breeding point of view, but it is necessary from the point of the health and general well-being of the people. The milk supply of our cities is probably the worst and most expensive in the whole world, which fact in itself is a proof of the crying need of the dual purpose cow. We do not need beef and the country does not want it, but milk and draught we must have and it is indisputable that these qualities can and must be combined in the cow of the future.

In this note I, of course, have not touched details of any kind but have confined myself to basic policy, because and until we have our policy based on sure economic foundation we can do nothing. The only practical and sound cattle breeding policy is dairying plus draught qualities ; the one is hopeless without the other and both are inseparable.

PROPOSED RUBBER RESEARCH INSTITUTE.

DURING the month of August, 1923, a Provisional Committee was appointed by the Government under the Chairmanship of the Secretary for Agriculture, Straits Settlements and Federated Malay States, to consider certain points that had arisen in connection with the proposal to proceed with the formation of a Rubber Research Institute.

The personnel of the Committee was as follows :—

Secretary for Agriculture, S.S. and F.M.S. (Chairman);
Secretary to High Commissioner ;
Mr. R. J. B. Clayton (District Officer, Lower Perak) ;
Mr. R O. Bishop, Ag. Agricultural Chemist (in the absence of Major Eaton) ;
The Chairman of the Planters' Association of Malaya ;
The Chairman of the Malay Peninsula Agricultural Association ;
The Chairman of the Rubber Producers' Association of Malaya ;
The Hon'ble Mr. J. M. Campbell ;
The Hon'ble Mr. C. Ritchie ;
The Hon'ble Mr. Choo Kia Peng :
Mr. S. Wierman.
Mr. H. C. Pinching (Senior Scientific Officer, R.G.A.).

The Committee was instructed to give particular attention to the following questions : —

(*a*) Whether there should be an official or unofficial majority on the Board.

(*b*) Chairmanship of the Board.

(*c*) Representation of the Planters' Association of Malaya.

(*d*) Provisions of funds in the initial stages, and whether and to what extent the duty on rubber under the Export of Rubber (Restriction) Enactment should be utilised for the purposes of the Institute.

A meeting was held at Kuala Lumpur during the month of October, and the Report of the Committee was subsequently forwarded to the Federated Malay States Government which it is understood has the Committee's suggestions under consideration.

The Secretary to the Committee was Mr. C. Ward Jackson, and at their meeting the thanks of the Committee were expressed to him for undertaking the work.

Received for publication 17th December, 1923.

BRIEF RECOMMENDATIONS REGARDING RICE MILLING FOR PADI PRODUCERS AND EMPLOYERS OF LABOUR.

The following circular was distributed in September to all District Officers and to some estates:—

AS agriculture is tending to take a progressively more important position in the industrial life of Malaya, more attention must be paid to the fundamental requirements of our agriculturists and the labouring classes.

Amongst our agricultural pursuits, the production of rice is of premier importance, for rice is the staple food of the country and on its price all other industries depend.

Malaya is highly favoured in being situated near a cheap and abundant source of supply of rice, but available rice land is diminishing in proportion to increase of population in most rice producing countries, and our chief source of supply at present cannot be reckoned as permanent. Therefore it is incumbent upon all classes who have the interests of the country at heart, to encourage the extension of our rice fields and thus help to reduce our huge annual expenditure on imported rice.

Local rice is more wholesome than any grade of imported rice and on this account employers of labour should show their patriotism by demanding more locally grown rice. Another way in which employers of labour can encourage local production is to purchase padi in place of rice and mill the padi under their own supervision. These notes, based on local experience, are compiled to assist padi producers, employers of labour and others who may wish to mill padi to decide on the form of mill most suitable for use under different circumstances.

A.—Districts which produce excess padi in good seasons only and where padi is not readily saleable.

The "lesong tangan" and "lesong kaki" are well known amongst padi cultivators in Malaya and are invaluable for use by agriculturists who require to mill for their own daily needs only. In certain districts and in good seasons the production of padi exceeds the requirements of the district or of the family and as a ready sale for padi within the district is often not possible, the padi has to be exported long distances for sale. In place of exporting padi to towns for sale, much labour and expense in transit can be saved if the padi is first milled because the proportionate volume of rice is less than 50 per cent. of the bulk of the padi and the weight of the rice from any volume of padi is approximately 63 per cent. of the weight of the padi. Thus, by converting the padi into rice a saving is effected in the number

of bags required, in freight charges, in porterage and in bullock cart costs or often the rice can be sold to local estates which would not purchase padi.

Under these conditions the best method of milling the padi if no source of power is available, is to use the "kisaran." The "kisaran" can mill about 20 gantangs of padi in an hour, that is, it mills 6-7 times more rapidly than the "lesong tangan." Moreover, rice milled by the "kisaran" is much less broken than that milled by the "lesong tangan."

In Krian district a "kisaran" costs $25 including freight to Parit Buntar Station, but there is no reason why this mill cannot be made anywhere in Malaya once a model one is obtained as a sample. The mill is described in the *Malayan Agricultural Journal*, Volume XI, No. 6, 1923. The reason why they should be made on the spot is that the chief material (white ant clay) from which they are made is brittle when dried and liable to crack and crumble if roughly handled on the railway or in transit by other means.

The chaff can be separated from the rice after milling, by hand, using the "niru" or by making use of a steady breeze, but the readiest method is to use a box winnowing machine ("pengipas"). The "pengipas" simply consists of a box in which a fan is rotated by hand to create the breeze necessary to blow away the chaff from the mixture of rice and chaff which is poured in a steady stream through the breeze. Two coolies can winnow 200 gantangs an hour by using this machine, which costs about $33 in Krian, but can easily be made by any Chinese "tukang."

B.—DISTRICTS IN WHICH A REGULAR SUPPLY OF PADI IS AVAILABLE AND WHERE SOURCES OF POWER EXIST.

This category refers mainly to large producing areas where the producers always have a large quantity of padi for sale at harvest.

The surplus produce grown on these areas is generally purchased by commercial millers who dispose of the rice to wholesale dealers and employers of labour. It is this latter class who can benefit most under these circumstances and even make a profit by installing their own small power mills and operating them with the power supplied from existing rubber machinery. For instance, the manager of a rubber estate situated in or near such an area, can purchase padi directly from the growers, mill it and retail it to his coolies to their advantage and with profit to the estate. The best machine in this instance is one of the "Englebnrg" type. This type of machine is made by several firms of which the best known are Messrs. Douglas & Grant and Mesers. McKinnon, both of Scotland. The mill may be obtained through Messrs. McAlister & Co , who have branches in the larger towns of Malaya, or through Messrs. Guthrie & Co., or Messrs. R. Young & Co , of Penang. It is sold under various names, "The Planters' Mill," the "Engleburg Huller," the "British Rice Huller," etc., and the cost and power required depends on the size since it is made in several sizes. The type recommended is the Planters' Mill No. 1 which costs $650 locally at present (this price including a stout iron stand) and requires about 7 B. H. P. for

efficient driving. It is compact, sound and simple in construction, and the wearing parts are easily replaced.

The optimum speed is 500 revolutions per minute. At this speed the mill outturn of rice should reach about one hundred gantangs (700 lbs.) per hour, unless the padi is insufficiently dry or is of poor quality when it may be necessary to mill it twice, thus reducing output to about 60 gantangs per hour. The mill works quite well at slower speeds also but more breakage results and usually a few grains of padi escape unhulled.

The mill is equally effective with raw and with parboiled padi, the only difference being that slightly more breakage of the rice is experienced in milling raw padi. The rice produced is not rendered deleterious from the point of view of "beri-beri" disease since the milling is limited to hulling, no polishing of the grain being effected. The cost of erecting this mill should be small unless a separate mill room is required. The cost of fitting the machine to existing rubber machinery would vary according to the length of belting and the number of pulleys required and whether any additional shafts were necessary. A drying-floor is advisable since the padi must be thoroughly dry before being milled otherwise the percentage of broken rice is certain to be high. If parboiled rice is desired a drying-floor is a necessity. (For particulars of parboiling, *see M. A. J.* Vol. XI, No. 6, page 158).

Another form of this machine includes a polishing drum. This form may also be used with safety from the point of view of beri-beri, though it is better to remove half of the polishing flanges from the inside of the polishing drum.

C.—Districts in which a regular supply of padi is available, but where conditions do not include power.

The best machine in this instance is the improved hand-power rice huller shipped by Messrs. Douglas & Grant, and obtainable locally through the Agents mentioned under B. This mill is a combined huller and winnower. It is simple in design, very compact, easily adjusted, strongly constructed and practically "foolproof." The hopper is fitted with an efficient adjustable feeder which delivers the padi to the hulling discs in an even stream and a neat winnowing attachment blows away all the husks after hulling. The resulting rice is very wholesome and free from any injurious effects from the point of view of "beri-beri." This mill is eminently suitable for small estates not requiring a large amount of rice daily, as its outturn is only 15 gantangs of rice per hour, and the hand labour involved in working it is very light. The machine might also be fixed to a motor cycle pulley as the power required is very small since one man can easily work the mill. Before milling, care must be taken that padi is free from stones, nails or other hard particles which are liable to damage the grinding surfaces. The mill costs $400 and spare parts are readily available.

Should the padi obtained for milling be very mixed or imperfectly dry it will probably be necessary to pass the padi through the mill, then separate the escaped padi from the rice, and remill the padi. The quickest and easiest method of effecting this separation of rice from padi is to run the mixture down an inclined sheet of "battery screening" of three-sixteenth inch mesh, when the rice will drop through the screening whereas the padi will run down the incline and can be collected at the bottom. If the padi is mixed it may be necessary to run it down the "separator" three times.

(Particulars of this separator can be had on application to the Economic Botanist, Department of Agriculture, Kuala Lumpur).

H. W. JACK,

Economic Botanist, Department of Agriculture,

S.S. & F.M.S., Kuala Lumpur.

KUALA LUMPUR,

Dated, 12th September, 1923.

LONDON MARKET PRICE LIST, 4th QUARTER 1923.

Oil Seeds.

Castor (Bombay)	-	£20—£21.15 per ton.
Coconut (desiccated)	-	43/6—44/6 per cwt.
Copra (Ceylon)	-	£29.10 per ton.
Do. (Straits)	-	£27.10 „ „
Cotton (Egyptian)	-	£11.5- £11.10 per ton.
Do. (Bombay)	-	£9—£10 per ton.
Croton		27/6—32/6 per cwt.
Gingelly (Chinese)	-	£23.5—£24.10 per ton.
Do. (Bombay)	-	£24.10 per ton.
Groundnuts (Gambia) (undecorticated)	-	£17.2.6 „ „
Do. (Chinese) (decorticated)	-	£21.12.6—£22.5 per ton.
Linseed (Bombay)	-	£22.5 per ton.
Do. (Plate, New Crop)	-	£16.12.6—£17.5 per ton.
Palm Kernels (West Africa)	-	£18.10 per ton.

Oils.

Castor (Madras)	-	49/- per cwt.
Do. (Pharmaceutical)	-	58/- „ „
Do. (1st pressing)	-	53/- „ „
Do. (2nd pressing)	-	52/- „ „
Coconut (Cochin)	-	50/- „ „
Do. (Ceylon)	-	44/- „ „
Cotton seed (Egyptian, crude)	-	37/6 „ „
Do. (Bombay)	-	36/6 „ „
Groundnut (Oriental, crude)	-	48/6 „ „
Do. (English)	-	48/- „ „
Linseed (Calcutta)	-	42/6 „ „
Do. (Plate)	-	41/6 „ „
Palm (Lagos)	-	£36.15 per ton.
Do. (Congo)	-	£36 per ton.
Palm Kernel	-	38/ per cwt.

Oil Cakes.

Coconut	-	£7.15—£8.10 per ton.
Cotton	-	£6.10—£6.15 „ „
Groundnut (undecorticated)	-	£9.5 per ton.
Linseed	-	£11.15 per ton.
Palm kernel	-	£6.5 „ „

Essential Oils.

Cajeput	-	3/3 per lb.
Camphor (Chinese, crude)	-	3/3 „ „
Do. (Japanese, refined)	-	3/9 „ „
Do. (oil)	-	72/6 per cwt.
Cinnamon (Ceylon, leaf)	-	4¾d. per oz.
Citronella (Ceylon)	-	4/6 per lb.
Do. (Java)	-	4/7 „ „

Essential Oils—*Contd.*

Clove	-	9/- per lb.
Lemon (Grass Cochin)	-	2½d. per oz.
Lime (West Indian, expressed)	-	7/- per lb.
Do. (do. distilled)	-	4/- „ „
Nutmeg	-	4/3 „ „
Patchouli (Penang)	-	30/-„ „
Vetiver (Bourbon)	-	25/-„ „

Spices.

Capsicums (East Indian)	-	40/-—45/- per cwt.
Do. (Nyassaland)	-	60/-—65/- „ „
Chillies (Zanzibar)	-	40/-—45/- „ „
Do. (Nyassaland)	-	50/-—53/- „ „
Do. (Japan)	-	125/- per cwt.
Cinnamon (Ceylon)	-	8¾d.—11½d. per lb.
Cloves (Zanzibar)	-	1/3½—1/5 „ „
Do. (Penang)	-	2/6—3/- „ „
Ginger (Japanese, Cochin)	-	70/-—80/- per cwt.
Do. (Jamaica)	-	150/-—185/- per cwt.
Mace (Bombay and Penang)	-	1/6—2/- per lb.
Nutmegs (Singapore and Penang)		
110's	-	11½ per lb.
80's	-	1/2 „ „
64's—57's	-	1/7—1/8 per lb.
Pepper (Singapore, black)	-	1d. per lb.
Do. (do. white)	-	6d. „ „
Turmeric (Bengal)	-	65/- per cwt.

Drugs.

Areca	-	45/- per cwt.
Cocaine (hydrochloride)	-	16/6 per oz.
Ipecacuanha (Matto Grosso)	-	7/3 per lb.

Natural Dyestuffs and Extracts.

Annatto (seed)	-	11d.—1/- per lb.
Gambier (block)	-	45/- per cwt.
Do. (cubes)	-	62/6—65/- per cwt.

Gums.

Damar (Singapore)	-	30/-—150/- per cwt.
Do. (Batavia)	-	120/-—160/- „ „
Dragon's blood (reeds)	-	£18—£20 „ „
Do. (lump)	-	£11—£28 „ „

Fibres.

Cotton (F. M. American)	-	19.60d. per lb.
Do. (Egyptian Sakellaridis)	-	21.10d. „ „
Hemp (African sisal)	-	£35.15 per ton.
Do. (Manila, J. Grade)	-	£33 „ „
Kapok (Java)	-	1/2½ per lb.
Do. (Indian)	-	11d. „ „

Foodstuffs.

Cocoa (Ceylon plantation)	- 60/-—105/- per cwt.
Coffee (Malay, plantation)	- 70/-—100/- „ „
Do. (Malay, Liberian)	- 60/-— 65/- „ „
Sago (pearl)	- 24/-— 30/- „ „
Do. (flour)	- 16/-— 17/- „ „
Sugar (white, Java)	- 52/6 per cwt.
Tapioca (Penang flake)	- 3½—3¾ per lb.
Do. (Penang flour)	- 18/-—22/ per cwt.

Miscellaneous Chemicals.

Acetic acid (glacial)	- £73—£74 per ton.
Do. (80% comml)	- £48—£49 „ „
Acetone (pure)	- £127—£130 per ton.
Ammonia (.880)	- £33— £34 „ „
Calcium acetate (grey)	- £21.10—£22.10 per ton.
Citric Acid	- 1/5 per lb.
Creosote	- 9½d. „ „
Formalin (40% vol.)	- £64 —£65 per ton.
Lime juice (raw)	- 1/9 —2/6 per gallon.
Do. (concentrated)	- £22 per basis[1]
Sodium bisulphite, 60—62%	- £21 —£23 per ton.
Sodium sulphite (anhydrous)	- £25—£26 „ „

[1] Basis = 108 gallons, 64 ozs. Citric acid per gallon.

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THE

Malayan Agricultural Journal.

Vol. XII. February, 1924. No. 2.

DECENTRALISATION.

IT is desired to draw attention to the advisability of Planters and others, who require the assistance of the Agricultural Department in any way, referring in the first instance to the local Assistant Agricultural Inspectors. Assistant Agricultural Inspectors are provided throughout the Federated Malay States and the Straits Settlements as follows:—

STATION.	AREA COVERED.
Butterworth ...	Penang and Province Wellesley.
Taiping (for Perak North) ...	Districts of Larut and Matang, Kuala Kangsar, Krian and Upper Perak.
Batu Gajah (for Perak South)	Districts of Kinta, Lower Perak and Batang Padang.
Kuala Lumpur ...	The State of Selangor.
Seremban ...	The State of Negri Sembilan.
*Raub (for Pahang West) ...	Districts of Kuala Lipis, Raub and Temerloh.
Pekan (for Pahang East) ...	Districts of Kuantan and Pekan.
Malacca ...	Settlement of Malacca.

As regards Singapore there is so far only a Sub-Inspector of Agriculture stationed there; he works directly under the Chief Agricultural Inspector at Kuala Lumpur, and the Chief Agricultural Inspector visits the settlement of Singapore from time to time. In 1925 however it is hoped to have an Assistant Agricultural Inspector stationed in Singapore.

* At the present time owing to shortage of Staff there is no Assistant Agricultural Inspector at Raub, and the Assistant Agricultural Inspector, Negri Sembilan is temporarily in charge of Pahang West also.

In some parts of the Peninsula Assistant Agricultural Inspectors have been provided only during the last few years, and it is probable therefore that the public are not sufficiently aware of the existence of these officers and of the purposes which they serve.

Very often enquiries are sent direct to the head office in Kuala Lumpur by persons who desire planting material or who require technical advice and assistance in connection with some pest or disease. In such cases reference should obviously be made first to the Assistant Agricultural Inspector for the locality concerned: this officer may be able to give immediately the assistance or information desired or at any rate he will be in a position to forward a communication to the appropriate technical officer at headquarters. It may be that a crop is attacked by some insect pest which he cannot identify; he will then arrange for a proper specimen packed in the right way to be sent to the Entomologist at Kuala Lumpur, ensuring at the same time that such assistance or advice as can be given will duly reach the enquirer. If however enquiries of this nature are sent direct to headquarters in Kuala Lumpur it is possible that insufficient information may be sent with them or that proper specimens may not be sent or that the specimens may not be properly packed; instances of this frequently occur, and indeed sometimes useless specimens reach the headquarters office at Kuala Lumpur without any accompanying letter or label so that it is impossible to say from whom or for what reason they were sent. Such cases occasion both delay and disappointment. A further serious disadvantage is that by such procedure the Assistant Agricultural Inspector is left in ignorance of a matter affecting agriculture in his particular territory of which he should properly be informed.

In this connection I would repeat again what I wrote in paragraph 71 of my Annual Report on agriculture for the F.M.S. in 1922 (published as supplement to the F.M.S. Government Gazette of October 5, 1923) as follows:—

> *Paragraph 71.*— "With the inauguration of the new system by which the Assistant Agricultural Inspectors in the various States and Settlements add certain lines of instruction work to their duties as Inspectors of plant pests and diseases, a notable departure has been made. It is hoped that in time all classes interested in agriculture will come to regard the local agricultural officers as their natural guides, councillors and friends in all agricultural matters; and that the local officers will serve as useful links between the research officers at headquarters in Kuala Lumpur and the planting community of all races throughout the country. As an aid to this end it is important that the Assistant Agricultural Inspectors keep in close touch with the District Officers, who are the interpreters of the people's needs and the pivot of the whole administration, and instructions have been given to the local agricultural officers to carry this out in practice.
>
> I feel sure that the better the officers of the Department and their work are known the more they will be used and appreciated."

In Johore the Inspector of Agriculture, Johore Bahru is the head of the State Department of Agriculture and as such all enquiries on agricultural subjects in that State should naturally be addressed to him. By arrangement between the respective Governments the services of the research officers of the Department of Agriculture, S.S. and F.M.S., have been made available in Johore, so that the Inspector of Agriculture can obtain their advice and assistance in technical matters, in the same manner as can the Assistant Agricultural Inspectors in the Colony or in the F.M.S.

To sum up, the public are requested to treat the Assistant Agricultural Inspectors as the local representatives of the Department of Agriculture, and as a general rule to get into communication with them before writing direct to the headquarters of the Department.

A. S. HAYNES.

Kuala Lumpur,

1st February 1924.

SUMMARY OF THE WORK OF THE INSPECTION DIVISION FOR THE FIRST THREE QUARTERS OF 1923.

By F. W. South and F. Birkinshaw.

THE information given in this article is abstracted from the first three quarterly reports of the Chief Agricultural Inspector during 1923. It has been customary to publish these reports as they have been written, but, during the past year, space has not been available and three are, therefore, appearing together.

A.—Quarter January 1st to March 31st.

Estate Visits.

In all 131 Estates were visited; 14 were visited more than once and 31 by request of their Managers. This compares with 92 Estates visited during the last quarter of 1922. The objects of these visits were mainly in connection with disease control; a few were for the purpose of seeing new crops; while in Johore, four were visited at the request of the Secretary of the Rubber Restriction Committee.

Rubber Diseases and Pests.

Pink Disease, (*Corticium salmonicolor*).—There were new reports of this disease from 8 estates not previously infected. The disease was reported from two new localities in Penang Island during January, making a total of three small centres of infection in the Island. It was also reported for the first time in the neighbourhood of Sitiawan. As usual the disease became more prominent during spells of wet weather in the old infected areas. Routine measures for its control were maintained everywhere and enforced when necessary. The main difficulty in enforcing control is still that land owners will leave infected branches lying about after cutting them, instead of burning them immediately. Prolonged teaching by the Department's officers, even combined with regular prosecutions mainly for this fault, seem to be without effect.

Mouldy Rot (*Sphaeronema fimbriatum*).—This disease was newly reported from 1 Estate in Perak North, 4 Estates in Negri Sembilan and 1 in Johore.

In Perak North the disease spread to a new area of 20 acres adjoining the area formerly infected near Padang Rengas. This is a further instance to add to the already striking accumulation of evidence that the disease is conveyed about the country by human agency. Unfortunately it seems impossible to control the movements of wandering Chinese and Javanese tappers. Much of the area originally infected in Perak was free from the disease during this quarter and tapping was resumed on such previously infected holdings as had shewn no further signs of attack.

Generally speaking a spell of dry weather during this quarter effectively checked the disease in Selangor, Negri Sembilan, Pahang, Malacca and Johore.

In Selangor the only places infected were two small holdings at Sepang and one at Beranang. In the latter locality the disease was of recent occurrence and the land owner was to be prosecuted for failing to carry out the prescribed treatment fully. In Negri Sembilan it was difficult to find a single case of Mouldy Rot. More regular attention to treatment in addition to the dry weather were responsible for this.

In Malacca the disease appeared for the first time on 6 or 7 holdings in the Malaka Pindah neighbourhood, but was quickly got under control. The previously infected areas showed very few cases, but there is no doubt that wet weather conditions will bring back the disease, which should be particularly virulent in Sebatu and Sungei Rambai mukims. In these two mukims rubber is grown under conditions most favourable to the disease, on old padi land on which there is a thick undergrowth of bush and rubber seedlings. The fact that many owners are absentees adds to the difficulty of having such land effectively cleaned up.

In Johore the conditions in Muar were very bad during the early part of the quarter, more especially at Panchor where the Department had to carry out the work of treating a block of 25 small holdings under the supervision of the Special Field Officer. A total of 28 acres was thoroughly treated at a cost of $61. During January a bad outbreak occurred on a Chinese estate near Johore Bahru, nearly the whole area of 580 acres being affected. Control measures were immediately commenced and were successful.

Black Stripe Disease (*Phytophthora* sp.).—This was newly reported on 1 estate in Pahang West and on 3 in Negri Sembilan. Otherwise it calls for little comment.

Cyphella sp.—During wet weather in January reports were received from 5 or 6 estates in Selangor of damage caused to the renewing bark of certain trees by a fungus, sometimes mistaken for Mouldy Rot disease, but in reality quite different. This fungus appears as a flat, white, fan-shaped mycelium which frequently starts its growth at the angle of the tapping cut and vertical guiding channel, or in the corresponding angle at the top of the renewing bark. It spreads out over the surface of the renewing bark and slowly penetrates and kills it. Treatment by means of the usual mixtures of Agrisol and water, or brunolinum, tar and water will destroy it easily. Affected trees should not be tapped until they show no further signs of the fungus. The white mycelium is attributed to a species of the genus Cyphella, but its identity is doubtful, as fructifications have not yet been found. Isolated cases of this disease have occurred during several years past.

Coconut Diseases and Pests.

Beetles. (*Oryctes rhinoceros* and *Rhyncophorus schach.*)—The usual routine work on the control of these insects has been maintained

everywhere. In Penang and Province Wellesley good progress has been made, though much more work remains to be done to remove suitable breeding grounds. In the coast districts of Selangor the results have been disappointing in view of the work done; the Assistant Agricultural Inspector, Selangor, will, however, continue his efforts to increase the efficiency of the work. Much work is still needed in parts of Johore, where it is receiving regular attention. Casual accumulations of village refuse and cattle owner's manure heaps are two of the most prolific types of breeding grounds for the black, or rhinoceros, beetle and are the most difficult to get rid of effectively, since, when they have once been cleared up, they are promptly formed again, as soon as the inspecting officer's attention is temporarily removed to a different locality.

Brachartona catoxantha.—This serious pest of coconuts appeared at Permatang Pauh and Permatang Ara and also at Permatang To Jaya in Province Wellesley, at the first two places in February and at the last in March. A serious outbreak on the coconuts around Batu Gajah town was reported on February 22nd by the Assistant Agricultural Inspector, Perak South. In Selangor there was a small outbreak at Sabak Bernam, that by March had been almost overcome by natural controls, parasitic insects and a fungus (*Botrytis* sp.); a new outbreak occurred, however, about 1 mile away on a holding of about 10 acres in extent.

There was an attack on coconuts at Dong in Pahang West during January: by the end of the quarter the insects had entirely disappeared from this locality, but a new outbreak had started in a kampong about 200 yards to the South East.

It is peculiar that these attacks frequently occur in areas known to have been attacked in former years. This tends to indicate that the pest is always present in these localities, but is normally kept under control by its natural enemies. Outbreaks of the pest only occur when for some reason the natural enemies lose control: at present artificial measures of control consist of encouraging the renewed increase of the parasites of the pest. Any other measures on tall trees are impracticable or nearly so.

At Batu Gajah a certain area of tall trees was sprayed with water by the Ipoh fire brigade. Very large numbers of caterpillars were knocked off the trees and subsequently destroyed. This area was much freer from the pest in the next generation of caterpillars. Unfortunately a suitable water supply was not available for the fire engine through all the infected area round the town.

Nettle Caterpillars.—A minor pest recorded as doing some damage in Penang Island and in Selangor was *Thosea* sp.

White Flies.—Specimens of these were forwarded to the Entomologist from Province Wellesley. Other specimens, probably the same insect, were found on coconuts at Batu Gajah and elsewhere.

Padi Diseases and Pests.

Stem borers.—Both the Assistant Agricultural Inspector, Penang and Province Wellesley, and local Malays were of the opinion that there were a far greater number of these pests present in Province Wellesley during the recent padi season than there were in the previous season. Unfortunately it was impossible to ascertain which species had been responsible for the damage observed.

The Assistant Agricultural Inspector also recorded a statement made by several local growers that the bird known in Malay as Ruak-ruak exercises an important control over these pests. This statement seems to be sufficiently well supported to be worthy of further investigation.

Rats.—As usual reports of damage by these pests were received from various places where padi was ripening or being harvested during the quarter.

A further stock of ½ ton of barium carbonate was received and was distributed at cost price as required. A supply of ¼ ton for use in the Colony only was ordered, together with 5 gross of rat traps; both poison and traps will be sold at cost price in the coming padi season.

Lalang and Blukar.

From all parts of the Colony and of the Federated Malay States reports were received that many Asiatic owners of rubber holdings had been making efforts recently to clear their land of lalang and blukar, as a reasonable profit was again obtainable on rubber.

As the owners' former plea of poverty no longer held good, action was to be taken by Inspecting Officers, and was to be strictly enforced, to ensure that dirty holdings should be cleaned up during the coming quarters of the year.

The success of Giant Mimosa, *Mimosa invisa*, in eradicating lalang was proving somewhat doubtful. In several instances it was observed that, after from one and a half to two years of vigorous and successful growth, this plant fruited heavily and then died out. The prompt reappearance of patches of lalang in such areas proved that the cover crop had not been present long enough to kill out all the roots of the grass. The cause of the death of the Mimosa is not clearly understood as yet. Possibly the cover would renew itself after some months; this remains to be tested.

The Assistant Agricultural Inspector, Selangor, stated that in coastal regions observations during 1922 indicated that the common passion-flower will overcome lalang in about a year. The use of the passion-flower for this purpose on inland areas is doubtful; general experience would show that it is not safe to rely on it to kill lalang.

Water Hyacinth.

Apart from routine work to remove such patches of this weed as were found, a special gang worked on the Perak River around Bandar under the supervision of the Assistant Agricultural Inspector, Perak South.

Pests and Diseases of Other Crops.

Mistletoe, (*Loranthus* spp.) Dalu api or Daun api api (M).—The species of this plant are pests in various parts of the country and appear to be growing more plentiful. Fruit trees in native holdings are frequently attacked, as are kapok trees; while rubber trees not infrequently harbour this pest and occasionally suffer considerable damage. It is distributed by the agency of birds. Action was being taken to have it removed and burnt when found. Where advice is disregarded such action is enforced, as the plant is a pest under the definition in the Agricultural Pests Enactment.

Acatina fulica.—The Giant snails were slowly diminishing in numbers at Butterworth. At the other infected locality in the Province, they were reported to be multiplying slowly and spreading. Advice was given as to the measures to be adopted for their control.

Die-back of Cloves.—Attention was drawn to this in the Annual Report of the Chief Agricultural Inspector for 1922. (Malayan Agricultural Journal Vol. XI, No. 10, p. 253.) It is commonly associated with the presence of one or more borers in the branches of the trees. Considerable damage is done to the older trees on Penang Island and on Bukit Mertajam and the disease might be worth investigating.

Notes on General Agriculture.

Rubber.—Generally speaking a fairly definite spell of dry weather everywhere during the quarter caused the "wintering" of this crop to be very regular, though leaf-fall was earlier in some localities than in others.

The improvement in the price of rubber resulted in the reopening of tapping on the majority of small holdings. Occasionally, however, especially where the full output allowed is not easily obtained, small holders continued to sell their coupons at about 35 cents per kati and to leave their trees untapped.

The Young Producers Restriction Committee, on which the Chief Agricultural Inspector served, reported at the end of February.

Coconuts.—The price of copra rose during the quarter to the neighbourhood of $10/- per picul.

The dessicated coconut factory in Province Wellesley, referred to in the Annual Report of the Chief Agricultural Inspector 1922, published in the Malayan Agricultural Journal Vol. XI, No. 10, p. 256, appeared to be already a profitable enterprise.

Padi.—The harvest was nearly completed in most parts of the Peninsula, except in Malacca, during the quarter. A summary of it will appear in the Annual Report of the Chief Agricultural Inspector for 1923 and in consequence will not be given here.

An additional area of land was acquired for the Malacca padi experiment station at Klebang Besar, making the total area 16 acres. Repairs to the dam were completed and arrangements were in progress to obtain an access road and a site for the store, and thus to complete the whole station in readiness for the next season.

A cultivation experiment was started and plots of different green dressings were sown.

The Assistant Agricultural Inspector, Selangor, stated that arrangements were proceeding for enlarging the padi area in Bagan Nakhoda Umar, so that this mukim should eventually have the largest padi area in Selangor. He called attention to the importance of planting selected pure line strains of padi on this new area from the very beginning.

The Assistant Agricultural Inspector, Negri Sembilan, stated that surveys were being carried out in Rembau and Kuala Pilah with a view to constructing permanent, in the place of several temporary, dams.

Experiments to determine if suitable green manures will improve old bendangs and also to improve mining slimes for padi cultivation were in progress in Perak North.

Fruit.—The Assistant Agricultural Inspector, Penang and Province Wellesley, remarked that fruits in season were plentiful in the markets and reasonable in price. In other parts of the country the fruit crop early in the quarter varied considerably from one locality to another; in certain places durians, rambutans and pulasans were plentiful.

The orchard of fruit trees imported from Australia and planted on an estate near Batu Gajah was reported to be doing well and should give useful information in the future. The Assistant Agricultural Inspector, Perak South, tried to pursuade owners of land in certain Malay Reservations to plant up a few marcotted fruit trees, such as Chiku and Limes, obtained from the grower at Telok Anson. The Malays, however, considered the price of $1/- per plant more than they could afford.

Roselle.—Small quantities of seed were distributed in Province Wellesley and in Negri Sembilan. The Assistant Agricultural Inspector, Perak South, was growing a small quantity of this plant to provide seed in two new Malay Reservations.

Tapioca.—The Assistant Agricultural Inspector, Selangor, stated that a tapioca mill was erected on an area of land planted with this crop in Kuala Selangor district, and that the cultivation of this crop

appeared to have been successful. This is believed to be the only tapioca mill in Selangor.

Instructional Work.

Padi Demonstration.—Early in March the Economic Botanist gave a very useful demonstration of the selected strains of padi at the Titi Serong Experiment Station in Krian. This was attended by Penghulus and other Malays: all the officers of the Inspection Division who were able also attended. The Assistant Agricultural Inspector, Perak North and the Junior Agricultural Assistant, Taiping, assisted the Economic Botanist. The Assistant Agricultural Inspector, Perak North, remarked that the Malays who attended the demonstration appeared to grasp something of the methods of selection and the good results to be expected therefrom. He considered that the demonstration had done much to awaken keenness to give the selected padis a fair test.

Roselle.—The roselle demonstration plots at Kota Bahru and Malim Nawar in Perak South were doing well: one at Sungei Raya was only fair, but might improve; while the fourth at Gopeng was a failure, probably because the soil was too sandy and became too dry.

A demonstration of stripping roselle for retting was given by the Assistant Agricultural Inspector, Selangor, at the demonstration plot at Batang Kali on March 16th. This plot has not been a real success for reasons which are not quite clear. The plot at Tanjong Malim was a complete failure, probably owing to unsuitable soil and lack of cultivation. New plots were planted in January and February, one at Kapar and two at Klang; these shewed signs of much greater success, provided they obtained sufficient rain.

Show.—A very successful Agri-Horticultural Show, at which the Assistant Agricultural Inspector, Negri Sembilan, assisted and the Chief Agricultural Inspector acted as a judge, was held in Seremban on March 24th. The number of exhibits was so large that they were considerably crowded in the limited space. This was particularly noticeable in the fruit and vegetable sections. Malays appear to be taking an increasing interest in these shows.

B.—QUARTER APRIL 1ST TO JUNE 30TH.

Staff Changes.

Mr. South, Chief Agricultural Inspector, left for home on leave on May 19th, Mr. F. Birkinshaw was appointed to act for him during his absence.

Inche Mohamed Noor, a Senior Agricultural Assistant, was appointed to act as Assistant Agricultural Inspector, Perak North, to replace Mr. Birkinshaw. Inche Mohamed Zin bin Haji Yusope was appointed an Apprentice in the Department for the Straits Settlements and assumed duty in Malacca on June 12th.

Estate Visits.

Altogether 73 estates were visited by the Inspection Staff of which 33 were visited by request of the Managers or Agents. Thirteen were visited more than once. The majority of these visits were in connection with pest and disease control. They also include four visits made in Johore by request of the Rubber Restriction Committee.

Diseases and Pests of Rubber.

Pink Disease (*Corticium salmonicolor*).—This disease was newly reported from 4 estates in Selangor, 2 in Negri Sembilan, one in Pahang West and from one in Johore, making 8 new reports in all.

No further reports of the presence of the disease have been received from Sitiawan. In Selangor a new, but not heavily, infected area was found at Ulu Klang, while badly infected small areas are still being found in Ulu Selangor and are receiving attention. Routine control measures are being maintained everywhere and call for no special comment.

A branch of Gardenia attacked by Pink Disease was forwarded by the Acting Assistant Agricultural Inspector, Perak North, for verification.

Mouldy Rot. (*Sphaeronema fimbriatum*).—Part of the infected area in Perak North is still giving much trouble. The disease is being well controlled in the parts where the best control work was instituted when the disease was first discovered, but in the part of the area which is the least accessible the position is not satisfactory. Supervision of this latter area is rendered difficult because of its distance from any main road and the cultivators are very difficult people to deal with. An attempt will be made to come to some arrangement whereby rubber coupons will be refused to the small holders who do not follow instructions given them.

No fresh reports have been received of any appearance of this disease outside the area previously affected.

In Selangor a little Mouldy Rot is still to be found at Sepang. It is receiving attention. At the end of the quarter it was reported that no signs of the disease could be found in Ulu Langat

The position in Negri Sembilan is still satisfactory in that the number of cases found in holdings has been very few. Dry weather partly accounts for this, but it is also due to some extent to the fact that small holders are beginning to realise the seriousness of the disease and the real need for control measures.

In Malacca a good deal of trouble was experienced with small holders in the area at Sungei Rambai, Sebatu and Batu Gajah, who showed great reluctance to carry out instructions for control of the disease. During the last fortnight in June a concentrated effort was made in these areas to try and affect an improvement. A Notice

Server has been given temporary inspection powers under the Ordinance for these areas. The co-operation of the District Officer has been obtained. It is hoped that the infliction of heavier fines, the stoppage of coupons to holders who do not carry out treatment and the temporary appointment of an inspecting officer especially for the localities concerned will all combine to effect an improvement in the control of the disease.

The Inspector of Agriculture, Johore, reports that Muar district still remains the centre of the heaviest infection, especially at Panchor and Gresek. An improvement in the conditions in Batu Pahat is reported.

Black Stripe. (*Phytophthora* sp.).—A few cases of this disease have been reported from Ulu Langat in Selangor and from Seremban and Batang Benar in Negri Sembilan. It is still in evidence at Jelebu and Pertang. In Johore a report of Mouldy Rot from one estate proved on investigation to be Black Stripe.

Fomes lignosus.—The Inspector of Agriculture, Johore, reports:—

"Lack of treatment in the early stages has given this disease a firm hold on many properties and its efficient treatment at the present juncture presents great difficulties." A statement of this kind emphasises the importance of thoroughly treating at the outset the scattered infected patches to be found in the majority of young clearings throughout the country.

Mistletoe.—In March last a firm of Estate Agents approached the Department on the question of the possibility of various species of local mistletoe, known as Dalu Api or Api-Api, becoming wide-spread on Rubber estates and doing considerable damage to the trees. It was mentioned that these local mistletoes were giving much trouble on certain estates, more especially in Malacca. Reports on this subject have now been received from all Assistant Agricultural Inspectors and the position appears to be that various species of mistletoe are present everywhere, growing mainly on fruit trees. In only a very few cases were these parasites found to any extent on rubber. Removal of mistletoe from cultivated trees is now being enforced and this policy will be continued.

No other pest or disease of rubber calls for special mention this quarter.

Pests and Diseases of Coconuts.

Beetles. (*Oryctes rhinoceros* and *Rhyncophorus schach.*)—In Perak South ravages by the Black Beetle increased in certain localities in the Kinta District. New mining lands have been opened in the neighbourhood and coconut trees thereon have been killed or cut down, thus forming good breeding places for the pest. The grubs were also found in cattle manure in the compounds of Bengali owners. A concentrated effort has been made to get all the coconut stumps and trunks and the manure heaps cleared up, and good progress in this respect had been made at the end of the quarter.

The Black Beetle is still doing much damage in the coastal districts of Selangor although recent prosecutions for not clearing up manure heaps appear to have had a little effect on some of the cattle owners of the neighbourhood.

In Johore in the Batu Pahat and Cucob districts the Red Stripe Weevil is doing damage. In these districts there are large areas of the sago palm and the refuse left about after removal of the sago affords breeding places for the pest. The inaccessibility of these districts makes control of the pest a difficult matter.

Brachartona catoxantha.—In Perak North small outbreaks of this pest occurred in the Krian District at Sungei Kota and Sungei Megat Aris. The pest did little damage and at the end of the quarter the attack had died out as a result of heavy parasitisation in which the fungus *Botrytis* sp. played an important part. These localities suffered from attacks in April 1921.

In Selangor the pest is reported from Sepang. There have been attacks in former years here also.

In the two localities in Province Wellesley the pest is now heavily parasitised, especially by the fungus.

In Perak South the attack in the vicinity of Batu Gajah is now over. Here insect parasites appear to have been the main factor in control. Altogether about 100 acres were affected and the attack lasted through 4 generations of the pest.

In Pahang West the attack at Dong is over, as is also the attack reported last quarter in Kuala Selangor district.

Lalang and Blukar.

During the quarter a good deal of attention has been given by the whole of the Inspection Staff to the clearing up of dirty holdings, in accordance with the change of policy on this question as outlined in the last quarter's report. It is bound to be a long while before any great improvement will be generally apparent, but gradual progress is reported by most of the Assistant Agricultural Inspectors In small holdings the eradication of lalang is an object very difficult of attainment and progress is bound to be slow.

Dirty kampongs are specially a danger in Mouldy Rot areas, as thick vegetation between the rubber trees prevents free movement of the air. In the stagnant damp atmosphere which obtains this disease is very persistent and difficult to control. Concentrated and continuous efforts are being made to bring such holdings into a better condition of sanitation, and the clearing up of lalang and blukar in Mouldy Rot areas is looked upon as an important item in the control work of this disease.

Water Hyacinth.

During this quarter, as in the last, the Perak North Gang has still been engaged upon clearing up areas near Taiping. The clearing

of the weed from an old mining land area accounts for the gang's more than usually prolonged stay in the vicinity of Taiping. At the end of the quarter arrangements were being made to send the gang for the annual clear up of the Sungei Perak between Kuala Kangsar and Bota. In Perak South the swamp at Malim Nawar again received attention.

Pests and Diseases of Other Crops.

Mango Branch Borer. (*Rhytidodera simulans*, White.)—During the quarter an examination of the Mango trees in Krian showed that this pest is prevalent through the whole district. Attempts to control its ravages are being made.

Notes on General Agriculture.

Padi.—A progress report on the results up to date of the distribution of pure strain seed has been prepared and published in the Malayan Agricultural Journal Vol. XI, No. 11, p. 335. The records obtained so far emphasise the need for a definite scheme of distribution with careful, continuous and systematic control. The work so far done has provided much useful information indicating what strains are likely to be the most suitable for various localities. There are also indications that the pure strains, after being grown a few years in a fresh locality are likely to give better results than when first introduced.

Cultivators in all parts of the country are now showing more interest in the pure strains than before, as is evidenced by the applications for seed being greater than in the previous year. This is an encouraging result of the time spent by the Staff last season in making the superiority of the pure strains known to cultivators and the demonstration given by the Economic Botanist and Assistant Agricultural Inspectors at Titi Serong in March.

In many districts, including Perak, planting will be late again on account of the continuance of dry weather.

The test stations at Talang in Perak and at Permatang To Jaya in Province Wellesley are being planted this season under the same arrangement as for the last season.

The Experiment and Test Station in Malacca has been the scene of busy operations. At the end of the quarter nearly the whole area had been ploughed, a Cletrac tractor being used for the purpose. Harrowing will follow.

The Assistant Agricultural Inspector, Negri Sembilan, reports that one concrete dam with wooden divisions has been built at Rembau and it is hoped that a second will be completed and in readiness for the coming season.

Fruits.—The mango season in Krian shows promise of being a good one.

A heavy crop of durians is expected in Upper Perak and Kuala Kangsar districts of Perak and in the Rembau and Kuala Pilah districts of Negri Sembilan.

The Agricultural Inspector, Johore, reports that the area under pineapples in Johore is increasing rapidly. Fruit has been plentiful throughout the quarter and prices have fallen to $1/- per hundred.

Roselle.—In Selangor a demonstration of stripping and retting was given at Kapar early in June.

In Perak South the demonstration plots at Kota Bahru and Malim Nawar have been cut and retting was in progress at the end of the quarter. A crop of ground nuts is being planted in each case as a rotation before the next planting of Roselle.

Patchouli.—The Inspector of Agriculture, Johore, reports as follows :—"Some little interest has recently been evinced in the cultivation of Patchouli and slightly over 100 acres are under cultivation at present. A small distillation plant has been established near Johore Bahru. The price obtained for the oil is at present from seven to nine dollars per pound."

Instructional.

An Agri-Horticultural Show was held in Kuala Lumpur from June 30th to July 2nd inclusive and was well attended. The Assistant Agricultural Inspector, Selangor, as Secretary for the Agricultural Section, put in a lot of hard work and succeeded in organising in a creditable manner a very difficult Section.

Many insect specimens for this show were collected by the Inspection Staff in outstations.

A show was also held in Pekan on June 16th but no details are yet available regarding it.

In Pahang East a series of lectures on pruning fruit trees and other subjects of general agricultural interest were given by the Assistant Agricultural Inspector.

General.

The Inspector of Agriculture, Johore, on behalf of the Secretary for Rubber Restriction, examined a further number of estates.

C.—Quarter July 1st to September 30th.

Staff Changes.

On August 18th Mr. Nock, Acting Assistant Agricultural Inspector, Pahang West, proceeded to England on leave.

Certain changes among the staff of Malay officers were made in order to allow Apprentices in training to attend the second part of the Lecture Course.

On July 12th Inche Ismail bin Haji Salleh and on August 1st Inche Osman bin Hitam were appointed Federated Malay States Malay Apprentices in the Department.

On September 8th Inche Mohd. Saikh, Malay Apprentice, Bagan Datoh, was transferred to Titi Serong Experiment Station to undergo a course of training with a view to his possible appointment next year as Padi Inspector, Perak. Inche Alang, Acting Sub-Inspector of Coconuts, Krian, is being similarly trained with the same object.

Estate Visits.

During the quarter 40 estates were visited including 5 by the Acting Chief Agricultural Inspector. Of these 16 were by request of Owners or Managers and 6 were visited more than once. The majority of these visits were made in connection with diseases of rubber, a few in response to requests for advice regarding other crops and two, in Johore, by request of the Rubber Restriction Committee.

Diseases and Pests of Rubber.

Pink Disease (*Corticium salmonicolor*).—This disease was newly reported from 2 estates in Perak North, 3 in Selangor and 2 in Negri Sembilan making a total of 7 newly reported estates.

In Kuala Kangsar District, Perak North, it has been impossible to spare as much time to enforce control of this disease as one could wish, owing to the necessity to concentrate on the control of Mouldy Rot. Consequently in some localities the disease is not receiving all the attention it should from some small holders. An effort will be made to pay more attention to the control of "Pink" so soon as the Sub-Inspector of the District can be released for a while from the mouldy rot area, which takes up the whole of his time for the present.

In Batang Padang and Lower Perak Districts less difficulty than formerly is being experienced in getting small holders properly to treat this disease. In many instances verbal instructions are all that is required to ensure measures being taken and the formal issuing of notices under the Enactment can be dispensed with.

In Selangor the Assistant Agricultural Inspector reports that this disease appears to be far less in evidence than at any time in his experience. This applies more particularly to Ulu Selangor. An arrangement whereby the District Planters' Association of Ulu Langat agreed to report to the Assistant Agricultural Inspector all cases where heavily attacked holdings were noticed by those employed on restriction work, is working satisfactorily. This method of co-operation between District Planters' Associations and the Inspection Division might be extended with advantage to all concerned.

Mouldy Rot. (*Sphaeronema fimbriatum*).—In Perak North, so far as can be ascertained, this disease is still confined to the area previously infected. A determined effort is being made to improve matters in the more inaccessible portion of the area where conditions,

were reported to be far from satisfactory last quarter. Three Malay small holders who had stubbornly refrained from carrying out control measures in a satisfactory manner, were prosecuted and fined $15/- each. Even fines, however, do not in many cases attain the result desired in the case of Mouldy Rot, where control measures include the cessation of tapping for a period. It is satisfactory, therefore, to be able to report that the District Officer has agreed to co-operate by withholding the issue of rubber coupons to the worst offenders, until we certify that satisfactory control measures have been taken. During the quarter coupons have been withheld from 32 persons and the latest reports indicate that this method of dealing with the problem is likely to prove successful.

In Selangor this disease has been newly notified from one estate in Kuala Langat. But for this the position remains unchanged.

This disease is newly notified from one estate in Negri Sembilan. Otherwise the position is the same as reported last quarter. During this quarter 5 convictions for failure to treat were obtained.

In Malacca the position is still far from satisfactory. The disease has now spread to the mukims of Machap, Serkam, Kemuning and Tampoi, of which Machap is the worst infected. No improvement can be reported in the position in the mukims of Sungei Rambai, Sebatu, Batu Gajah and Merlimau. This is extremely disappointing after the amount of effort put in by the Inspection Staff in these areas and the hopes entertained last quarter that at last some effective action would be taken towards enforcing proper control measures. The difficulties are (*a*) the great number of absentee land owners with a Chinese tapper only as occupier of the land (*b*) the amount of lalang and blukar in holdings which keeps the air in a stagnant and damp condition very favourable to the growth and spread of the disease (*c*) a general failure to realise the gravity of the situation and the fact that control measures carried out in a slipshod fashion are as bad as no control measures whatever. I hope in the near future to make a personal investigation of the position in Malacca and to be able to report better progress next quarter.

In the Muar District of Johore this disease was virulent notwithstanding a long spell of dry weather. The infected lands here are coastal and low lying, which is doubtless the reason why dry weather does not serve as a check to the disease. The position in Muar generally appears to be very similar to that in Malacca.

In Segamat District a spell of dry weather during the earlier part of the quarter exercised a distinct check upon the disease, but owing to a succession of heavy afternoon rains in September, the disease had increased at the end of the quarter.

In Batu Pahat the disease persists in small localised patches on the coastal lands.

Small sporadic outbreaks in Johore Bahru have been kept under strict supervision which has prevented any further spread.

Black Stripe (*Phytophthora* sp.).—In Negri Sembilan this disease still persists at Jelebu and Pertang. No further cases have been seen at Pantai during the quarter. The disease is newly reported from one estate in this State.

Fomes pseudo-ferreus.—The Inspector of Agriculture, Johore, reports that this disease has taken a heavy toll of trees on two estates in the State.

Pests and Diseases of Coconuts.

Beetles. (*Oryctes rhinoceros* and *Rhyncophorus schach*).—Reports from Perak South show that much progress has been made during the quarter in getting rid of the breeding grounds of both these insects in the District of Kinta. The Mining Companies have made considerable strides in destroying dead coconut trees on their lands and in and around Lahat a thorough inspection of the manure in cattle sheds has resulted in the discovery and treatment of many black beetle breeding grounds.

An increase of these pests around Port Swettenham led the Assistant Agricultural Inspector, Selangor, to visit the locality in September. Breeding grounds of the black beetle were found in the shape of decaying grass and manure hidden by cut grass. These have received attention.

In Kuala Selangor the black beetle is still much in evidence and, unfortunately, is likely to remain so. It breeds in heaps of cattle manure which is used regularly in the locality as a top-dressing for Sireh plantations. The problem of enforcing the treatment of the manure is difficult, as in many instances, an order for the removal of a heap results in its being carried away and hidden in undergrowth on adjoining State Land. All that is possible is being done to restrict the numbers of this pest.

In Province Wellesley the routine work of getting rid of decaying coconut stumps is being steadily continued.

Brachartona catoxantha.—The Assistant Agricultural Inspector, Perak South, reports that the coconuts at Batu Gajah, which were very badly defoliated, are gradually recovering their normal appearance. The attack at Sepang, reported last quarter, only affected a small area and the pest has now disappeared.

In Province Wellesley the attack at Permatangs Pauh and Ara affected a much larger area than the earlier attack at Permatang To' Jaya. In the former case an area of about 2 miles in length by from 100 to 200 yards in width suffered. As stated in the last report the fungus parasite, *Botrytis* sp., is now effectively controlling the pest.

Thosea sp.—In Perak North this pest was found doing slight damage to a small isolated area of Coconuts.

Pests and Diseases of Padi.

Leptocorisa sp.—The Padi fly or "pianggang" has appeared in quantity in two localities in Negri Sembilan, namely Johol and Simpang Inas.

Nymphula depunctalis.—This pest has been responsible for a certain amount of damage to padi nurseries at Pekan Darat and Permatang To' Jaya in Province Wellesley.

Lalang and Blukar.

From most parts of the country reports to hand indicate that there is a certain amount of improvement observable in respect of the condition of small holdings, though such improvement is of necessity slow. The Inspector of Agriculture, Johore, has given much attention to this matter and he reports progress, but adds that it will be necessary to maintain a vigorous campaign as the work done is usually very superficial.

Water Hyacinth.

The annual clearing up of the Sungei Perak between Kuala Kangsar and Bota by the Water Hyacinth gang in Perak North was commenced on August 3rd and was completed on September 29th.

Pests and Diseases of Other Crops.

The Assistant Agricultural Inspector, Province Wellesley and Penang, reports that borers are doing considerable damage to some of the Nutmeg and Clove plantations in Penang. This matter will receive further attention.

Collections are being made of species of Loranthus for examination by the Economic Botanist for identification and with the object of investigating their distribution, both geographically and from the point of view of favourite host plants. Work so far done indicates that rubber may only be attacked to any great extent by one or two species. The practical value such work may have in determining the best measures for the control of the pest is obvious.

Several minor pests and diseases of plants of small economic importance have been received from various parts of the country for identification by the Government Entomologist and Mycologist and for advice as to treatment.

General Agriculture.

Rubber.—As indicated under the heading "Lalang and Blukar" there is a noticeable improvement in the sanitation of Rubber lands throughout the country. This applies more especially to small estates and Chinese owned properties and small holdings. During the quarter under review it does not apply generally to Malay holdings, as owners of such are occupied with padi planting.

The Inspector of Agriculture, Johore, sums up the situation in that State as follows:—" The steady and somewhat favourable condition of the rubber market has induced many companies to put into operation schemes for the general improvement of their properties. Activities in such matters as white-ant control, clearings of jungle stumps and timber, drainage, soil conservation and improved treatment of disease have been noted." He adds, however, that the small holders in Johore show no inclination voluntarily to improve their holdings.

The Assistant Agricultural Inspector, Province Wellesley, reports that during August and September much damage was done to low-lying rubber plantations in the North District by severe wind storms which felled many thousands of trees.

Coconuts.—The dessicated coconut factory at Bagan Ajam, mentioned in the first report of the year, is still running satisfactorily.

Padi.—Everywhere, including Krian, this crop is exceptionally late owing to late rains. In many parts the date of actual planting is a month and even six weeks behind the scheduled date. The planting in an area in Bagan Tiang, Krian, was made even later than it would otherwise have been by a heavy flood which washed away young plants in the nurseries and necessitated re-sowing. The Sanglop Valley area in Kinta is being planted again this year. This valley runs from Gopeng to Kota Bahru and was formerly used as a deposit for slimes from Gopeng Mines. Unfortunately the area is subject to floods and it is, therefore, decided to raise its level by further sliming to commence immediately after next years crop has been harvested. To minimise the danger of floods for this season and to afford a better control of water, a channel has been cut through the area. The growing of padi on this slimed land is of interest in view of the amount of dredged, slimed land which will later on be available for agricultural purposes.

Roselle.—This crop is still being grown successfully by two estates, the one in Perak and the other in Negri Sembilan.

Fruit.—The fruit season was a good one in most localities.

Tapioca.—In the first quarterly report for this year mention was made of the alienation of land at Bukit Kapar for this crop. During the past quarter enquiries have been received from Kedah and Penang regarding the advisability of alienating other areas for this crop.

Instructional.

(1) Padi Experiment Stations under this Division.

(*a*) Malacca.—The total area of this Experiment Station is 23 acres. Much of this area has been fallow for some years and was overgrown with low scrub, lalang and rushes. Its thorough cultivation by means of tractor was commenced last quarter and completed during this quarter. Even after being twice ploughed and harrowed three

times, some of the area was not in the condition expected; such parts, after flooding, were given a further ploughing and harrowing with native implements. Eighteen acres have been planted with padi this season. The dam was put in order before planting, but it is still far from satisfactory and leaked so badly after it had been in use for a few days that, had it not been for heavy rain at a convenient time it is probable that much of the planted padi would have been damaged, as it was last year. The dam has been repaired once more and will be further tested.

(*b*) Manurial experiment station at Pekan Darat in Province Wellesley. Ten acres of land has been secured on a six years lease and is being planted up throughout with one pure strain. No manuring has been done this season, as it is intended to find out first to what extent the soil varies in different parts of the station.

(2) *Padi Test Stations.*—In Perak North Talang bendang is again being utilised. Arrangements are being made to start a test station on similar lines in the Kenas Irrigation area. Land for this station has been promised and it is intended to settle about half a dozen Krian cultivators thereon and to have the area cleared ready for the establishment of the test station next season.

In Province Wellesley a test station is again being laid down at Permatang To' Jaya.

(3) *Distribution of pure strains.* —This season approximately 1,300 gantangs of pure strains padi has been distributed through this Division.

(4) *Demonstration Plots.*- Roselle. In Selangor the plots have not attained the object aimed at, namely, the establishment of Roselle as a small holders crop in the localaties concerned. Notwithstanding that the people at Kapar were shown how to ret the fibre and the owner of the ¼ acre plot was informed that his fibre, similarly rettted, could be sold for $11/- to 12/- a pikul, he made no attempt to harvest the remainder of the crop. No greater interest was shown in any of the localities where plots were laid down in Selangor.

At two localities in Perak South the outlook appears to be more promising, namely at Kota Bahru and Malim Nawar. Here the owners of the plots expressed themselves as pleased with results obtained and are keen to continue growing roselle. At the present moment the plots are in groundnuts as a rotation.

Yields.—Jalan Raja plot yielded at the rate of 2,360 lbs.

Kota Bahru at 1,900 lbs. and Malim Nawar at 1,600 lbs. per acre.

(5) *Lectures.*—The Assistant Agricultural Inspector, Perak South, delivered a lecture to the Penghulus of Kinta on the Black Beetle and Red Stripe Weevil, explaining their life histories and application of the control measures.

General.

Experiments with Greendressings on slimed dredged lands. At both Kamunting and Kota (Perak North) *Mimosa invisa* and *Tephrosia candida* give promise of being the most satisfactory plants so far tried for the purpose required. In both cases *Crotolaria striata* and *Tephrosia purpurea* have grown well, but these plants appear to be too small to provide the heavy dressing required, unless they are capable of maintaining a continuous cover under the conditions present by means of self sown seed *Cajanus indicus* has made slow growth in both instances and appears to be unsuitable for the type of soil. *Sesbania aculeata* has also proved unsatisfactory. Trials are being made with *Crotolaria usaramoesis*, which is a bigger plant than *Crotrlouria striata*, and with an undetermined species of Tephrosia which has grown well at Serdang.

Similar trials have been laid down on slimed dredged land near Batu Gajah.

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PROGRESS REPORT ON THE EXPERIMENTAL PLANTATION, SERDANG, FOR THE QUARTER ENDING 31st DECEMBER, 1923.

By B. Bunting.

FURTHER progress was made in the opening up of the Experimental Plantation, Serdang and the clean clearing of the newly opened 175 acre block was practically completed at the end of the quarter, the clean clearing of an area of about 25 acres of the block, situated on the lowest point, having to be held over until it could be drained. Arrangements have been made to drain this area and the work of clean clearing will be proceeded with immediatedly the draining operations are finished.

A start was made on the ploughing of this area by tractor and good progress should be made with this work during the next quarter.

Planting of Crops.

A number of small areas were planted up with different crops during the quarter, including a 10 acre block of varieties of coffee, but the area available for planting was somewhat limited and until the opening up of the 175 acre block is more or less completed further planting operations will necessarily be held up.

A large number of miscellaneous trees were planted up in the aboretum during the quarter.

Pests and Diseases

Insect pests have proved very troublesome on the planted areas and, in a large number of cases, spraying operations have been carried out on the recommendation of the Government Entomologist.

New Planting Materials.

The following material was received during the quarter under review :—

Palmyra Palm.—Seeds of this palm were received from the Department of Agriculture, Ceylon, and planted in the sand-beds in the nursery.

Cocoa.—Seeds of the Nicaragua variety of Cocoa were also received from the Department of Agriculture, Ceylon, but germination was very bad and so far only seven seedlings have been obtained.

Pili Nut.—A parcel of 50 seeds of the Pili nut (*Canarium ovatum*) was received from the Bureau of Agriculture, Manila and up to date about II have germinated.

Tuba Root.—Three varieties of *Derris* (tuba) have been received from the Botanic Gardens, Singapore and established in the nursery. Cuttings of two varieties named Tuba Gajah and Tuba Rimba were also received from Kuala Lumpur, but have not yet struck.

African Oil Palm.—A further supply of seeds were received from the Experimental Plantation, Kuala Lumpur and have been used for germination tests. Seed soaked in water at a temperature of 15°C commenced to germinate after 49 days from the time they were put in to soak, or 42 days after planting, whilst seeds planted out without any treatment commenced to germinate at 51 days after planting.

Brazil Nuts.—About 60 fruits of the Brazil Nut were received from the Experimental Plantation, Kuala Lumpur and on an average contained 16 seeds each. These were planted in specially prepared seed beds.

Bay Tree.—A supply of seeds of the Bay tree were received from Montserrat, British West Indies, but have not yet commenced to germinate.

Mulberry.—About 40 cuttings were received from the Government Plantation, Sapintas and planted in pots in the nursery. The majority of the cuttings appear to have been established. A further 6 large plants in boxes were received from the Experimental Plantation, Kuala Lumpur.

Hemp Varieties.—A number of young plants of *Furcraea gigantea* and *F. cubensis* were received from the Arghan Co., Telok Anson and are doing well.

Pita Fibre. A small supply of Pita suckers were obtained from a Rubber Estate in the Kuala Selangor district for experimental purposes and are now well established.

Pineapples.—About 20 suckers were received from the Government Plantation, Teluk Anson and are all growing well in the nursery.

Papaya.—About 100 seeds of a variety of papaya, that originally came from the Transvaal, were received from the Manager, Government Plantation, Sapintas. Some of the seeds have germinated and it is hoped to raise a few plants for stock purposes.

Candle Nut.—A parcel of 750 seeds of *Aleurites montana* were received from the Superintendent, Botanical & Forestry Department, Hong Kong and have been planted in boxes in the propagating shed. So far the seeds have not germinated.

Lime Tree.—About 1½ lbs. of seeds of the West Indian Lime tree were received from Montserrat, British West Indies and planted in boxes.

Sweet Potatoes.—Three tubers of each of the following varieties of the sweet potato were also received from Montserrat:—Southern Queen, Victoria and North. They are all growing well in a small nursery bed,

Algaroba Bean.—A small quantity of seed of this flowering tree was received from the Experiment Station, Honolulu and a good percentage germination was obtained.

Kapok.—A number of rooted stumps were received from the Experimental Plantation, Kuala Lumpur and used for supplying.

Coffee.—A further supply of seed of varieties of coffee were obtained from the Experimental Plantation, Batu Tiga, but so far these have not germinated.

Nutmegs.—About 250 seeds were obtained from Balik Pulau, Penang for supplying purposes. Germination has not yet commenced.

Cola Nut.—A good supply of Cola Nut seed was received from Grenada, British West Indies and was planted in boxes. These seeds have shown fair germination and the young seedlings appear to be doing well.

ROADS AND BUILDINGS

The extension of the road through the planted area was continued and the surface of the portion between the Limes and the Croton blocks was covered with laterite. Additional drains were put under the new road where required in order to deal with storm water, which was washing away the surface in places.

A commencement was made on levelling the main road through the centre of the plantation and it is expected that the work will be nearly completed during the ensuing quarter.

The P.W.D. started work on the new entrance road to the plantation at the beginning of the quarter and excellent progress has been made in the construction of this road, which will be ready for use about March next.

New drains have been cut in the blocks planted with Kapok and Limes in order to drain the low-lying places in both these areas.

The following new buildings have been erected in the plantation during the quarter:—

1 Set of Cooly Lines (20 rooms)

1 Kitchen for do (5 „)

1 General Store with Office

1 Petrol & Oil Store (corrugated iron)

1 Cattle shed (3 stalls & 2 rooms)

Work on levelling up the factory site was continued and, with the aid of Decauville track on loan from the railway, good progress has been made on this work during the quarter.

GENERAL.

A number of plants were added to the herbarium during the quarter and further additions will be made as material becomes available.

Regular weekly visits of inspection were made during the period under review.

Numerous visitors were shown round the experimental plantation during the quarter. The Advisory Committee visited the plantation on the 29th October and inspected the work in progress. The Chief Secretary (the Hon'ble Mr. W. George Maxwell, C.M.G.,) accompanied by the Secretary for Agriculture (Mr. A. S. Haynes) also paid an official visit on the 5th December and made a general tour of inspection of the opened area.

Received for publication 4th February, 1924.

THE SOYA BEAN (GLYCINE HISPIDA).

By F. G. Spring.

A large quantity of Soya beans is consumed in the Peninsula, particularly by the Chinese. The bean is a native of China and Japan where it has been cultivated for food from time immemorial. It is also a favourite food amongst Tamils but is used to a smaller extent by them. In China it is a staple food of the country and to a good extent takes the place of rice there. The importance of growing such a valuable food in this country cannot be over estimated especially when one considers the large Chinese population. In most tropical countries dried beans are produced on a big scale but in Malaya the inhabitants have to depend to a very large extent on outside sources of supply.

The Soya bean has been experimented with from time to time in the Peninsula with varying degrees of success and it was considered that good returns could not be obtained here unless a particular type was imported or a variety acclimatized to local conditions.

On the instructions of the Secretary for Agriculture who had obtained information from the Hon'ble Mr. Choo Kia Peng a visit was recently made by the writer to Manchis, Pahang, as it was reported that the bean was being cultivated in that neighbourhood. It was found that upwards of thirty Chinese small holders are growing this crop, each to an extent of around one acre. The land is flat and undulating and the soil a rich friable clay. The majority of the plots have been under cultivation for five years and are now in a fine state of tilth.

The beans are grown as a catch crop amongst rubber until the shade from the trees is too great for the legume to thrive satisfactorily when it is then grown as a sole crop in rotation with rice, groundnuts and sweet potato.

The original source of seed was from China, but whether the good results obtained are due to this particular seed having become acclimatized or to its being a special variety suited to local conditions is difficult to say ; the question of soil may also be an important factor. The Department of Agriculture, S.S. & F.M.S. has experimented with seed purchased in the local market but the crops were not satisfactory and tests are now to be made with seed which has been obtained from Manchis.

The method of cultivation adopted by the Chinese is as follows :— The soil is changkolled to a depth of four inches and the seed dibbled in at distances of 18 inches apart, two seeds at each position a few inches apart. The seed is placed about one inch below the surface of the ground. Previous to sowing, all weeds are removed from the land and two subsequent weedings are done at intervals of one month. The

crop is ready for harvesting in about three months from the time of planting. The green matter is a valuable manure and is incorporated in the soil. The seed is separated from the pods by hand beating which is not a difficult process provided the pods have been well sun dried. The seed is thoroughly sun dried before being stored, It was difficult to ascertain the yield per acre but one of the small holders estimated a return of 40 katis of dried beans for each kati planted. The best yields are obtained when planting is done in the wet season but at such a time that the crop is harvested during dry weather.

The crops were not subject to insect pests or fungus diseases but a certain amount of damage was experienced by the pods beings attacked by birds. If the crop was grown on a larger area the loss in beans, per acre, would be very much less.

There are several varieties of Soya beans, one common type yielding yellow seeds and another black, the former is the more popular as a food and it is this one which is grown by the Chinese at Manchis. The Soya bean is a small erect annual plant growing to a height of about two feet but this varies considerably according to the class of soil in which they are grown. The plant produces a good amount of shade over the ground but not sufficient to render weeding unnecessary, the growth of weeds is, however, retarded to some extent.

The Chinese are fully aware of the value of a rotation of crops and by this means, and good cultivation they have been able to maintain equally good returns annually over a period of years. A suitable rotation is a cereal crop followed by a pulse and then a root crop and this is the system adhered to by the small holders of Manchis.

The Soya beans are consumed mostly by the growers themselves but any surplus stock is sold in Bentong or Kuala Pilah where there is a ready market for the produce which fetches from 6 to 9 cents a kati. The purchase price in the Kuala Lumpur market is 9 cents a kati.

The beans are eaten in a number of ways but are generally boiled and eaten alone or in conjunction with rice or other foodstuffs. They are also pounded into flour and made into cakes. In India the beans are eaten in the form of "dhal".

The inhabitants around Manchis are almost entirely self supporting as regards food and it is to be hoped that the growing of the soya bean may be taken up in other districts. The Department of Agriculture has several addresses of Chinese cultivators and any prospective grower desiring a supply of Soya beans, for planting purposes, should communicate with the Agriculturist.

The bean is known by the Chinese as " *Wong Tau* " (Cantonese) which means the yellow bean, in Hakka as Vong Theu and in Hokkien Ui^{n} Tau.

Note.—**In amplification of the above article a note has been received from the District Officer, Bentong, stating that the Soya Bean**

is grown not only at Manchis but also nine miles from Bentong on the road to Kuala Lumpur. The Chinese there are said to plant it in freshly cleared ground, not to manure it or cultivate the ground in any way ; and the bean is said to grow easily. Hakka vegetable gardeners in Raub are also said to grow the Soya bean freely, interplanted with other crops.

At Bentong there is a bean curd factory in an attap shed behind the town where the bean curd (or *Tau Fu* in Cantonese) is made for sale in the local market.

A.S.H.

Received for publication 17th January, 1924.

NOTES ON THE EXPERIMENTAL PLANTATION, SERDANG FOR THE MONTH OF JANUARY, 1924.

THE plantation is situated about 3 miles from Serdang in the State of Selangor and is roughly 150 feet above mean sea level.

The total area is approximately 1525 acres, 625 acres of which have been opened up and the balance of 900 acres kept in reserve.

New planting material received during the month included two varieties of Soya Bean (*Glycine hispida*) from Pahang, 25 varieties of Yams (3 varieties of *Dioscorea Esculenta*) and 22 varieties of *D. alata* from the Botanic Gardens, Singapore and three plants each of 4 varieties of Tea (*Camellia Thea*) from Kenny Estate, Jeram, Selangor.

Rain fell on 18 days during the month giving a total rainfall of 4.66 inches. The heaviest rainfall in 24 hours was .93 inches.

The maximum shade temperature recorded was 94°F and the minimum 64°F. The average maximum shade temperature was 90. 45°F and the average minimum 69. 74°F.

A cup-indicating anemometer was installed on the plantation and readings of the run of the wind were taken as from the beginning of the month. The total run of the wind for the month was 1212. 3 miles, the average run for the 12 hours from 6 a m. to 6 p. m. being 30. 74 miles and that from 6 p.m. to 6 a.m 8. 37 miles.

VISIT OF HIS HIGHNESS THE SULTAN OF SELANGOR.

H. H. The Sultan of Selangor, accompanied by Tengku Alam Shah (Tengku Panglima Raja, A.D.C.), Mr. A. S. Haynes (Secretary for Agriculture), Mr. B. Bunting (Agriculturist in Charge of Government Experimental Plantations), and other officers of the Department of Agriculture; with Mr. de Moubray (Collector of Land Revenue, Kuala Lumpur), visited the Government Experimental Plantation, Serdang on Wednesday January 16th 1924.

His Highness, with Tengku Alam Shah and Mr. Haynes left Kuala Lumpur about 8 a.m. by car, and arrived at the plantation, which is situated fourteen miles south of Kuala Lumpur beyond Sungei Besi, at about 9 o'clock. He was received by the various officials, the Penghulus of the Kuala Lumpur District, and about fifty Malay subjects of His Highness.

After signing the visitors book, His Highness and the party proceeded to the Seed Store, and thence to the nurseries which cover an area of ten acres. A tour of the nurseries was made, the features and uses of the different crops being explained. His Highness shewed a

great desire to see everything, and made many practical comments drawn from his intimate knowledge of local agricultural practice and crops.

Proceeding by car, His Highness then visited the highest hill on the plantation, from whence an excellent panoramic view of the opened area was obtained. Afterwards, he walked through the plantation, inspecting the field blocks of such crops as kapok, roselle, areca nut, limes, Mauritius hemp, bananas, pineapples, and the Chaulmoogra plant, from which is obtained the oil now used in the cure of leprosy.

At the conclusion, His Highness expressed his pleasure in visiting the plantation; and proceeded on the return journey to Kuala Lumpur at 11 o'clock.

The Penghulus and other Malays followed the progress round the plantation with great interest, many of them being anxious to procure planting material of crops which especially appealed to them as being suitable for planting on a small scale.

Received for publication 11th February, 1924.

A USEFUL PLANT FOR INDIA.

BY K. KUNHIKANNAN.

Reprinted from the Agricultural Journal of India, Vol. XVIII, Pt. II.

WHILE engaged in research work at the Standford University, California I had to look up references regarding a tree commonly known as Mesquite or Algaroba and was so impressed with its usefulness that I decided to take seeds with me to India. The tree is a native of Brazil but is either indigenous or cultivated in Argentine, Chile, Peru, Bolivia, Columbia, Central America, Mexico, Texas and the West Indies.

In Hawaii, where I had opportunities of observing the habits of the tree, it was introduced by a missionary in 1828. Since then it has spread over the islands, and now occupies in Oahu alone no less than 100,000 acres. The tree is, however, confined to the leeward portions of the island where it thrives from the sea coast up to an altitude of 2,000 feet. In this part of the island rainfall is scanty and in places so little that the localities may be little different from semi-arid desert. The windward side of the islands have, however, a different climate owing to the trade winds which blow practically throughout the year. Rainfall varies from 200 to 400 inches. Here the tree is but rarely found.

The Mesquite is a legume belonging to the Genus Prosopis which is represented by but two species in India. The following is the scientific description of the plant *Prosopis juliflora* :—

"A tree 10 to 20 M. tall, branches glabrous or minutely puberulous; stipules small setaceous, or aristate, sometimes obsolete; spines axillary, solitary or in pairs, straight, in sterile branches up to 5 cm. long, devaricate, sometimes very short or entirely absent; leaves glabrous or rarely pubescent, distant or in short branchlets, subfasciculate, common petiole 12 to 50 mm.; glands often small between the pinnae, and smaller between leaflets; pinnae often 1-jugate, rarely 2-jugate, very rarely 3-jugate; rachis 3.25 to 7 5 cm.; leaflets broadly oblong 4 to 6 mm. long, or linear 12 mm. to 2.5 cm. long, with intermediate forms straight or falcate, obtuse or pointed, the costa somewhat prominent beneath; inflorescence spicate, axillary or fascicate with the leaves, shortly pedunculate, 5 to 10 cm. long, dense or slender and subinterrupted; bracts minute, flowers glabrous outside or with few short scattered hairs, 3 mm. long, calyx 1 mm, long, the opening often ciliate, petals are often woolly inside at the apex,; stamens half as long again as the corolla; ovary shortly stipilate, villose: pod more or less arcuate or nearly straight, 5 to 15 cm. long, 4 to 12 mm. wide, before maturity often flat compressed, at maturity on both sides more or less convex, continuous outside, or between the seeds marked with depressions of transverse lines, mesocarp more or less spongiose, endocarp hard, often horny,"

The tree is very variable. In Texas it is little more than a shrub but further south in Mexico it grows into a large tree often attaining a height of 45 to 50 feet with a diameter of about 2 feet. The roots go down to great depths after water. This latter feature makes it specially adapted for growth in regions with scanty rainfall.

The flowers have a sweet scent and the flower spikes are from 4 inches to 6 inches long. There are two flowering seasons, one in April and the other about October. The pods are from 6 to 10 inches long and have a thick spongy pericarp containing syrupy matter. They turn yellow when ripe and drop to the ground. They are of high nutritive value and much relished by all kinds of stocks. Children in Texas also eat them. The pods are collected and ground to serve better as cattle food. The crop in the islands of Oahu alone is estimated at 25,000 tons annually and a factory has been established there to deal with this enormous output.

The value of the tree does not consist in the pod alone. The long flower spikes yield honey in abundance and in some parts of Texas and Hawaii this is the only source of honey for the large number of beehives kept. They produce an abundance of pollen. Out of the 600 tons of honey produced in Hawaii about 200 tons are derived from mesquite alone. A tree of about 30 feet spread is estimated to produce 2½ pounds of honey. One advantage the tree has over most other honey-producing trees is that it blossoms twice in the year, once about April and again in October. The April blossoms last till August so that save for a short period of about two months there are flowers nearly the whole year. A fairly continuous supply of honey is assured to bees. A second feature is that, provided there has been rain in the latter part of the year, there will be an abundance of flowers the next year no matter how dry the following summer is.

When grown to its full height the Mesquite is a very graceful tree and serves well as an ornamental tree in parks The wood takes on fine polish and is therefore used for furniture and cabinet work.

From the description given above, the value of the tree to India is obvious. Provided it can be naturalized —and there can be no doubt from the wide range of its habitat that it can be —it will go far to solve the problem of cattle famine. The large yield of pods averaging to 200-250-300 lbs. will provide a source of highly nutritive food especially in localities where from want of rain the cattle are liable to starvation. The adaptability to semi-arid regions makes it specially valuable. There are large tracts in India of this description where the tree may usefully replace other trees now growing wild or grown solely for firewood.

The Mesquite is equally important as a source of honey. One great obstacle to extensive bee-keeping in India is the scarcity of honey-yielding plants in the plains.

As a result indigenous bee-keeping has been confined to the hilly tracts where the drawback does not exist. With the introduction of the Mesquite there will be provided a continuous source of honey for the greater part of the year.

A large number of seedlings have been raised in Bangalore from the seeds brought down from Hawaii.* They seem to thrive well but their behaviour in their new home is yet too early to forecast. The tree is very variable as has been mentioned already. It is possible that it will exhibit the same variation in India as it has in other parts of the world. But whatever the variation, its great value as a source of highly nutritive cattle food is not likely to be diminished under the different conditions of this country.

Note.—Since the acceptance of the article for the Journal (Agricultural Journal of India), I have been informed by Rao Bahadur Rangachari, Lecturing Botanist at the Agricultural College, Coimbatore, that he saw several of these trees fairly full grown in a sandy tract near Madras and the appearance showed that they were thriving well. The possibility has occurred to me, therefore, of the introduction of the plant in other localities in India, more especially in parks and botanical gardens. If my surmise is correct, there is already valuable experience available of the behaviour of the tree under Indian conditions, and I trust those who have it will make it known to the public through the medium of this Journal. (K. K.)

*** A small supply of seed of this plant has been obtained by this Department from the Hawaii Experiment Station, Honolulu for planting at the Experimental Plantation, Serdang. The germination of the seed was good and about 600 seedlings have been raised from the small quantity of seed supplied.**

From the information available at present the plant appears to thrive best in the dry regions and it will be interesting to see whether it is possible to establish it under the moist conditions prevailing in Malaya. In order to test the tree under different conditions in this country it is intended to distribute the seedlings as widely as possible throughout the Peninsula and any one interested in its cultivation should apply to the Department of Agriculture, Kuala Lumpur, for seedlings without delay, otherwise arrangements will be made to dispose of the limited amount of stock now available for distribution.

B.B. (1-2-21).

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OBITUARY.

The Late Inche Ahmat bin Johar.

BY the death on January 31st, 1924 of Inche Ahmat bin Johar, the Department of Agriculture has lost a valuable officer, and the entire staff in expressing genuine and sincere sympathy to his sorrowing wife and relations deeply regret his untimely end.

Inche Ahmat was educated at the Malay College, Kuala Kangsar, and joined the Department of Agriculture on 20th May 1913. He was attached to the Inspection Division for training and was stationed successively at Kuala Lumpur, Taiping and Kuala Kubu until he was transferred to the Botanical Division on 1st July 1922.

He was promoted to the grade of Junior Agricultural Assistant on 1st July 1919 and was recommended for promotion as Senior Agricultural Assistant as a result of the examination in September 1923 in which he acquitted himself brilliantly, taking first place well ahead of all the other competitors.

Inche Ahmat was an intelligent and promising officer anxious to acquire agricultural knowledge and a keen student. He was interested in his work and aimed at benefitting his fellow-countrymen.

Temperamentally, he was modest, nervous and highly strung; he endeared himself to his fellow officers by his ability, thoughtfulness and refinement, and his loss is deeply regretted.

MISTLETOES ATTACKING CULTIVATED TREES IN MALAYA.

By W. N. Sands.

AMONG the common pests of cultivated dicotyledonous trees in Malaya are several species of mistletoe. These are semi-parasitic flowering plants, all belonging to the Natural Order, *Loranthaceae*. According to Gamble[1] some forty-five species are known to occur locally, but a few only attack rubber, fruit and shade trees to any extent, and these belong to the three genera, *Loranthus*, *Elytranthe* and *Viscum*.

The Malays have several terms for the parasites which are all forms of the Malay word, Dĕdalu, meaning mistletoe: for example, Nĕnalu (Kedah), Dalu and Dĕndalu (Province Wellesley), Bĕndalu (Riau-Johore), Gĕnalu (Trengganu), also Bĕnalu, Bindalu, Mĕnalu and Kĕmĕndalu. Further some of the commoner species are given descriptive specific names such as Dĕdalu api (fire), D. gajah (elephant), D. besar (large), D. asap (smoke).

In 1911 Bateson[2] recorded the occurrence of a species of *Loranthus* on rubber (*Hevea brasiliensis*) in Pahang, whilst in 1914, Brooks[3] gave an account of two species of *Loranthus*, which he did not name, attacking rubber on a few estates in Negri Sembilan and mentions that one of these was also found growing on a common melastomaceous plant, presumably Keduduk (*Melastoma malabathricum, Linn*). Since then reports of mistletoe infesting rubber and other trees have been received from various places.

During the past few months an effort has been made, with the co-operation of Officers of the Inspection Division of the Department of Agriculture and others, to obtain information regarding the species damaging cultivated trees in different parts of the Peninsula. The results of this preliminary investigation are now given.

Biology and Life History.

To those who are not familiar with these plant pests, a short account of the biology and life-history of them may perhaps be usefully included here. Mistletoes are mostly green-leaved, evergreen shrubby plants specially adapted for growing on dicotyledonous trees, *e.g.*, Rubber, Rambutan and Pomelo; they are not able to thrive on monocotyledonous trees such as Palms and Bamboos. They are parasitic because they withdraw from the internal tissues of their hosts, water and essential inorganic nutrient materials such as an ordinary terrestial plant obtains directly from the soil. They are not completely parasitic because they possess green leaves, or in the case of *Viscum articulatum,* flattened branches which contain the green colouring matter-chlorophyll in their cells and are therefore able to convert water and carbon-dioxide into organic food materials, namely

carbohydrates, by means of the energy derived from light. This phenomenon is known botanically as photosynthesis. Owing to this faculty of acquiring organic nutritive substances, the parasites do not as a rule destroy their hosts rapidly unless these are in poor condition and the infestation is a heavy one. In this respect mistletoes differ from certain of the lower and well-known fungus parasites which rely entirely on the organic food-stuffs already formed by green-leaved plants, and which often kill rubber and other trees fairly quickly.

The leaves of the local species of mistletoe vary considerably in size; those of *Loranthus grandifrons*, King, measure up to 10 inches long and 5½ inches broad, whilst those of *Viscum articulatum*, Burm, are reduced to minute scales. They are usually leathery and modified to limit the transpiration of water and conserve it during periods of the year when rainfall is deficient. At these times the hosts, and consequently the parasites, are unable to obtain a full supply of water; also during the "wintering" period of deciduous hosts the mistletoes would suffer unless their leaves were adapted to prevent the rapid loss of water.

Flowers are produced in abundance in the species under consideration and they also differ greatly in character, size and colour. In the genera *Loranthus* and *Elytranthe* they are hermaphrodite, that is both stamens and pistil occur in the same flower, whereas in *Viscum* the flowers are unisexual. The flowers of the former are adapted for pollination by insects whilst it is probable that those of the latter, although so small, are insect pollinated. Observations on *Loranthus ferrugineus* point to the fact that the flowers of this and other species are also pollinated by the beautiful little sun-birds of the group — Nectarinidae — as these have frequently been seen inserting their beaks in the flowers in search of food. In this connexion Keeble[5] states that the tube-flowered species of *Loranthus* of Ceylon are pollinated by a common honey-sucker which is also a species of Nectarinia, and that the bird was always to be found in the early morning visiting the flowers.

In *Loranthus grandifrons* the flowers are 3 inches long and rosy pink in colour; those of *Elytranthe globosa* are about ½ inch long and coloured greenish yellow, whereas those of *Viscum articulatum* are scarcely visible.

The fruits are one-seeded succulent berries, usually brightly coloured or white, with a fleshy exterior and often mucilaginous interior. The seed has a very sticky gelatinous coat which enables it to adhere closely to any surface with which it comes in contact. This gelatinous covering is able to absorb water from rain, mist or dew with the result that the seed is prevented from perishing; and further, it is the only means by which the seed on germination obtains the necessary water for growth until the haustorium or sucker has penetrated into the water-bearing tissues of the host.

It is practically certain that birds which feed on the berries are the chief means by which the seed is disseminated locally. The Malays state that birds are very fond of the berries, at any rate, these

have been seen frequently in considerable numbers in the bushy [illegible]. When *Loranthus ferrugineus*, [illegible] *Barnesii* are in full fruit, fruit-skins [illegible] seed can usually be found beneath trees [illegible] with these parasites, but investigations along this line with other indigenous species are incomplete. Observations in other countries have shown that birds after feeding on the pulp of the berries wipe their beaks against the branches of trees in order to clean them of the sticky seed which is distasteful to them; also they may void any seed swallowed on to branches in their excrement. Other possible agencies for dispersal are heavy rain which beats down the fruit; high winds and the natural fall of ripe berries from higher to lower levels of the host trees.

The seed on germination puts out a short stout cylindrical root-like body, the hypocotyl, which swells out at its free end into a disc on coming in contact with the bark of its host and forms what is known as a holdfast. From the central and lower portion of this the haustorium, or sucker, developes, which body is capable of penetrating to a considerable depth into the tissues of the host by means of solvent ferments and the pressure resulting from growth. When the source of water and food has been made secure by the haustorium the young shoot developes rapidly.

Humid conditions are essential for the successful germination of the seed.

The haustorium in forcing its way through the bark destroys this along its passage and eventually penetrates the wood and forms a close connection between the wood-vessels of the host and those of the parasite, so that water and raw food materials can be readily obtained.

As growth proceeds a rounded swollen mass of tissue forms over the place where the holdfast was attached to the host tree. The swellings may be large or small In *Loranthus pentandrus* they are very large. In old specimens they are often as large as a tennis ball and completely surround the branch, with additional large hypertrophied masses at points where the haustoria of secondary roots attach themselves to branches and twigs. (Plate ii Fig 1 A.B.). In the other local species under consideration the swellings, although present, are not as prominent. In all species of *Loranthus* and *Elytranthe* secondary branches arise at the original point of infection, also secondary branching roots which travel for considerable distances along and around the infested branch in different directions. At frequent intervals, ¼ inch on twigs to 1½ inch, or more, on larger branches, haustoria are formed along the side of the root-runner nearest the branch and enter it. (Plate ii Fig 4 (c)). From the upper side of the runner shoots arise which form thick bushy plants like the parent parasite. In this way a tree may become heavily infested from a single seed.

The two species of *Viscum*, namely, *Viscum orientale* and *V. articulatum* do not reproduce themselves by means of surface root-runners, but the original haustorium throws out short lateral out-

growths under the soft bark or cortex of the host which spread along and around it and develope further suckers which penetrate the wood. A certain amount of thickening takes place about the first point of contact with the host and large single masses of growth develope from it. (Plate i Fig 2.)

The haustoria continue to expand and multiply as growth proceeds. Eventually, the end of the branch of the host is killed as a result of the withdrawal by the parasite of all the water and inorganic food materials obtained from the soil and the destruction of the cambium, phloem and other bark tissues. In cases where the parasitism is heavy the whole tree may be so weakened that it dies. Many examples of useful trees which had been irretrievably damaged, or killed, by mistletoes were noted during the course of investigations in different parts of the Peninsula.

The original infestations of cultivated trees by mistletoes on estates, in kampongs, and on shade trees planted along roadsides were due, no doubt, to birds bringing the seed from neighbouring jungle or wayside trees which are known to support the species described below. Generally speaking, the parasites are found on the higher and outer branches of the trees they attack, that is, in places where they can obtain plenty of light. They do not, as a rule, thrive under dense shade, hence cultivated trees that are in poor condition may suffer more severely than those in good health ; but there are four common species which have been observed to grow and fruit well even under fairly densely shaded conditions during the greater part of each day, these are *Loranthus ferrugineus, L. pentandrus, L. grandifrons* and *Elytranthe globosa*. None of these species, as will be shown later, is very particular in its choice of host trees.

It is of interest to note that certain of the local species can parasitize each other, for example, *Loranthus ferrugineus* has been found growing on *L. pentandrus, Elyranthe globosa, E. Barnesii* and *Viscum articulatum*, whilst *Viscum articulatum* has been freqeuently observed on *Loranthus pentandrus, L. ferrugineus, Elytranthe globosa* and *E. Barnesii*, (Fig 5. Plate iii) but the most unusual case of hyperparasitism was noted on a Durian (*Durio zibethinus*) tree which was attacked by *Elytranthe Barnesii*. On this mistletoe was growing *Viscum articulatum*, and on *V. articulatum, Loranthus ferrugineus*. (Plate iii Fig 6.)

In this connexion it may be mentioned that to-date *Viscum articulatum* has only be found by the writer on other species of mistletoe, still at Rembau in Negri Sembilan it was recorded as growing on the Mangosteen (Garcinia Mangostana) and the Rambutan (Nephelium lappaceum), and in Penang on the Chenderai (*Grewia paniculata*) and Bodi (*Ficus religiosa*), and no doubt occurs as a direct parasite elsewhere.

The commonest species are *Loranthus ferrugineus, L. pentandrus* and *Elytranthe globosa*; these have been collected in all districts. Less common, but widely distributed, are *Loranthus grandifrons, L. pentapetalus, Viscum orientale* and *V. articulatum*, whilst

Elytranthe platyphylla and *E. Barnesii* have been collected once only, but the latter may have been overlooked as it resembles *E. globosa* when seen growing at a height on host trees on account of its swollen nodes and opposite leaves.

Description of Species.

The following is a brief description of each of the five most important species from the point of view of the injury done by them to cultivated trees. The descriptions, although derived chiefly from those given by Gamble[1], are supplemented by notes on the living plants and their hosts.

The two species *Elytranthe Barnesii* and *E. platyphylla* are of minor importance and need not be described here. As mentioned previously each has been collected once only, the former on the Durian (*Durio zibethinus*) and the latter on the Chempedak (*Artocarpus Polyphema*).

Although *Viscum orientale* has been found in great abundance on certain trees planted along roadsides, namely *Ficus indica*, *F. Benjamina* and *Albizzia moluccana*, it has not been collected on rubber or fruit trees. This species is readily recognized as it resembles in growth and foliage the well-known European mistletoe (*Viscum album*). Its berries, however, are red. The other species which is not described in detail, namely *Viscum articulatum*, is referred to above, and as there stated, appears to be mainly parasitic on oher species of mistletoe.

1. *Loranthus ferrugineus, Roxb.* (Plate 1 Fig 1.)

This is a much branched, bushy, wiry shrub with pendulous branches and long thin surface root runners. Small swollen masses of tissue occur at points where haustoria enter host. Bark brown, minutely lenticellate, uppermost parts like the under surface of the leaves and the inflorescence, covered with dense rusty matted short hairs. Leaves opposite or sub-opposite; leathery, usually uniform in shape on single plants, ovate to elliptic with a broad apex and rounded base; petiole short; about 3/10 inch long. Flowers clustered in the axils of the leaves and borne on short few-flowered inflorescences. Calyx tube short, densely hairy. Corolla ½ inch to ¾ inch long, rusty hairy on the outside and smooth within; club-shaped in bud, when open cleft on one side half way down and dividing into 4 lobes slightly incurved at summit. Stamens 4, anthers oblong, filaments broad, dark red. Ovary cylindric, style slender, dark red about 1/3 of its length, four-angled. Fruit a pear-shaped berry covered with dense rusty short hairs, becoming slightly paler in colour when ripe.

This plant is ubiquitous in lowland districts. It, however, rarely occurs on rubber (*Hevea brasiliensis*), although it grows on numerous native plants and most fruit trees. It is the only species so far found on the well known shade tree the Saman (*Pithecolobium Saman*). It has also been collected on Tapioca (*Manihot utilissima*) and the

common wayside plants the Kedudok (*Melastoma malabathricum*), and the Ara Perak (*Ficus alba*) as well as on certain species of mistletoe.

The following useful trees have been recorded as hosts of this species :—

Name.	Malay Name.	Botanical Name.
Avocado Pear	...	Persea gratissima, Gaertn.
Belimbing	Belimbing	Averrhoa Bilimbi, L.
Casuarina	Ru	Casuarina equisetifolia, L.
Gooseberry	Chamin-Chamin ; Chermai	Cicca acidissima, Blanco.
Governor plum	Kukum	Flacourtia cataphracta, Roxb.
Guava	Jambu biji ; J belawas	Psidium Guajava, L.
Jack Fruit	Nangka	Artocarpus integrifolia, L.
Jering	Jering	Pithecolobium lobatum, Benth
Kapok	Kapok ; Kabu-Kabu	Ceiba pentandra, Gaertn.
Langsat	Langsat	Lansium domesticum, Jack.
Lime	Limau Asam	Citrus Medica var. acida.
Mango	Machang ; Bachang	Mangifera foetida, Lour.
Orange	Limau manis	Citrus Aurantium, L.
Pomegranate	Delima	Punica Granatum, L.
Pomelo	Limau abong, L. besar	Citrus decumana Murr.
Pulasan	Pulasan	Nephelium mutabile, Blume.
Rain Tree	Saman	Pithecolobium Saman, Benth
Rambai	Rambai	Baccaurea Motleyana, Muell.
Rambutan	Rambutan	Nephelium lappaceum, L.
Rubber	Getah	Hevea brasiliensis, Muell.

2 *Loranthus pentandrus, Linn.*

A large, stoutly branched, bushy shrub. Large masses of hypertrophied tissue occur at points where primary and secondary haustoria enter host, these are rounded and become knobby and warty with age. Secondary roots stout. Bark grey to blackish grey; lenticles numerous, oval. Leaves thick, leathery, sub opposite or alternate, dark green, variable in shape and size, lanceolate to ovate elliptic, obtuse to acute at apex, tapering to cuneate at base, both surfaces glabrous, mid-rib stout prominent below, petiole stout under ½ inch long. Flowers in axillary, often clustered, short racemes which are grey-pubescent, as are the calyx, corolla and filaments of the stamens. Calyx tube ovoid, or pitcher-shaped, with limb shortly 5-toothed. Corolla in bud 7/8 inch to 1 inch long, cylindric above and inflated below; when open cleft to middle two-thirds of way down into five equal linear acute lobes which are reflexed at their middle, greenish outside and yellowish within. Stamens 5, erect, nearly as long as corolla lobes,

anthers linear. Ovary ovoid, style rather thick, angled. Fruit ovoid, dark green even when ripe, contracted and surmounted by the persistent calyx limb, at first mealy afterwards becoming glabrous.

Like the previous species this is found in all districts and has a wide range of native and cultivated host trees among these being the roadside plant the Kedudok (*Melastoma malabathricum*). It is common on rubber (*Hevea brasiliensis*) in some districts and often damages this tree severely.

Its hosts among cultivated trees are:—

Name.	Malay Name.	Botanical Name.
Belimbing -	Belimbing -	Averrhoa Bilimbi, L.
Cashew Nut -	Janggus -	Anacardium occidentale, L.
Chempedak -	Chempedak -	Artocarpus Polyphema, Pers.
Circassian Seed -	Saga -	Adenanthera pavonina, L.
Croton -	Puding -	Codiaeum variegatum, Blume.
Duku -	Duku -	Lansium domesticum, Jack var: Duku.
Durian -	Durian -	Durio zibethinus, Murr.
Gooseberry -	Chamin-Chamin; Chermai -	Cicca acidissima, Blanco.
Guava -	Jambu biji; J. belawas -	Psidium Guajava, L.
Jering -	Jering -	Pithecolobium lobatum, Benth
Kundangan -	Kundangan -	Bouea macrophylla, Griff.
Langsat -	Langsat -	Lansium domesticum, Jack.
Lime -	Limau asam -	Citrus Medica var: acida, L.
Mango -	Machang; Bachang-	Mangifera foetida, Lour.
Mango -	Mampelam; Ampelam -	Mangifera indica, L.
Mangosteen -	Manggis -	Garcinia Mangostana, L.
Orange -	Limau manis -	Citrus Aurantium, L.
Pomelo -	Limau abong; L. besar -	Citrus decumana, Murr.
Rambai -	Rambai -	Baccaurea Motleyana, Muell.
Rose Apple -	Jambu ayer -	Eugenia aquea, Burm.
Rose Apple -	Jambu ayer mawar	Eugenia Jambos, L.
Rubber -	Getah -	Hevea brasiliensis, Muell.
Sapodilla -	Chiku -	Achras Sapota, L.
Silk Cotton -	Kapok; Kabu-Kabu-	Ceiba pentandra, Gaertn.
Teak -	Jati -	Tectona grandis, L.

8. *Loranthus grandifrons, King.*

A large shrubby plant, branches stout with dark greyish brown bark. Lenticels rounded; branchlets slender, slightly swollen at nodes and dark brown; very young shoots and leaves covered with short felted grey hairs. Swollen masses of tissue not large at places where haustoria enter host. Surface root-runners long, fairly stout with rough bark. Leaves large, alternate, or sub-opposite, rarely opposite, leathery, broadly ovate or lanceolate, acute or acuminate at apex, rounded or cordate at base, both surfaces dull and almost glabrous, margin recurved, 5 to 10 inches long and 2½ to 5½ inches broad; mid-rib stout, very prominent below, main nerves curving upwards and joining near margin, petiole thick ½ inch to 1 inch long. Flowers on stout racemes from the axils of the leaves, or fallen leaves; racemes 2 to 4 inches long, densely covered with short felted grey hairs, erect or curved. Flowers 20-30; pedicels short, thick. Calyx tube short, cylindric, inflated at base, limb 5-6 toothed. Corolla tube long, slender, broadening upwards, base whitish, upper parts pink, 2½ to 3 inches long, slightly curved, lobes 5, reflexed, red within. Stamens 5, anthers linear, flattened, filaments hairy. Ovary ovoid, style slender slightly longer than stamens. Fruit ovoid, covered with short thick grey hairs, about ½ inch long, surmounted by the persistent calyx.

This species is widely distributed and fairly common in certain districts. Among its hosts are:—

Name.	Malay Name.	Botanical Name.
Silk Cotton -	Kapok, Kabu-Kabu -	Ceiba pentandra, Gaertn.
Mango -	Machang, Bachang -	Mangifera foetida, Blume.
Lime -	Liman asam -	Citrus Medica var: acida, L.
Pomelo -	Liman abong; L. besar -	Citrus decumana, Murr.
Rose Apple -	Jambu ayer mawar	Eugenia Jambos, L.
Rambutan -	Rambutan -	Nephelium lappaceum, L.

4. *Loranthus pentapetalus*, *Roxb.*

A much branched shrub, forming large masses of erect and pendulous branches. Bark brown to blackish brown, or grey on young seedlings, rather rough. Secondary roots long and fairly thick. Hypertrophied masses of tissue where haustoria enter host, not prominent. Leaves bright green, glabrous, leathery, opposite or sometimes alternate, somewhat variable in shape, but chiefly ovate-lanceolate, acute or acuminate at apex and tapering to base, 2½ to 4½ inches long and 1 to 1½ inches broad. Mid-rib prominent beneath, nerves faint, petiole ¼ to ½ inch long. Racemes solitary, or in twos or threes, from the axils of the leaves or fallen leaves, about 4 inches long, all parts bright red except tips of petals which are yellow. Flowers numerous on short thick pedicels; in bud all set parallel to the main axis of the inflorescence and constricted at the middle. Calyx cylindric, minute, limb obscurely toothed. Petals 5, the basal portion obovate, thick, glabrous and convex within; the neck transversely wrinkled, the upper portion strap-shaped, pointed, reflexed in flower, the whole about 2/5 inch long only. Stamens 5, inserted above the neck of petals. Ovary shortly cylindric, style jointed at middle. Fruit crimson, ellipsoid, shortened at end about ¼ inch long.

This is a widely distributed species, fairly common in some localities on native trees. It has been collected so far on two cultivated trees only, but without doubt occurs on others.

Name.	Malay Name.	Botanical Name.
Rambutan -	Rambutan -	Nephelium lappaceum, L.
Rambai -	Rambai -	Baccaurea Motleyana, Muell.

5. *Elytranthe globosa*, *G. Don.* (Plate 2 Fig. 3).

A thickly branched glabrous shrub. Bark brown to light brown on branchlets; lenticels numerous, oval, nodes swollen. Primary and secondary swellings where haustoria enter host, small or absent. Secondary roots robust, long, with numerous branches. Leaves leathery, dark green, mostly opposite, elliptic-ovate or ovate lanceolate, acuminate at apex and sloping to base, both surfaces smooth, shining, 3—4½ inches long and 1¼ to 2¼ inches broad; mid-rib prominent, nerves inconspicuous; petiole short about ¼ inch long. Flowers in small axillary racemes, single, or in pairs, or clustered, ½ inch long, 2 to 5 flowered, pedicels short, slender. Calyx tube pitcher-shaped, limb cup-like. Corolla in bud, narrow, thickened towards the apex

with folds below nodes, when open campanulate; lobes 6, sometimes 5, reflexed at middle, narrow, green to yellow usually with purplish tips and stripes. Stamens as many as lobes; style long; stigma large, capitate. Fruit an ovoid or globose yellowish berry, ¼ inch long.

This is a common species which is frequently found on rubber (*Hevea brasiliensis*) as well as numerous other useful trees. It has been recorded as growing on :—

Name.	Malay Name.	Botanical Name.
Belimbing	Belimbing	Averrhoa Bilimbi, L.
Cashew Nut	Janggus	Anacardium occidentale, L.
Chempedak	Chempedak	Artocarpus Polyphema, Pers.
Carambola	Belimbing batu	Averrhoa Carambola, Adans.
Casuarina	Ru	Casuarina equisetifolia, L.
Guava	Jambu biji	Psidium Guajava, L.
Jack Fruit	Nangka	Artocarpus integrifolia, L.
Mangosteen	Manggis	Garcinia Mangostana, L.
Rambai	Rambai	Baccaurea Motleyana, Muell.
Rambutan	Rambutan	Nephelium lappaceum, L.
Rubber	Getah	Hevea brasiliensis, Muell.
Sapodilla	Cheku	Achras Sapota, L.
Sentol	Sentol	Sandoricum indicum, Cav.
Silk Cotton	Kapok; Kabu-Kabu	Ceiba pentandra, Muell.

Control of Mistletoes.

It has been mentioned that mistletoes reproduce themselves by means of succulent berries containing sticky seed which are dispersed

chiefly by birds, therefore it is important that the parasites be recognized and exterminated at an early stage of growth. If the berries are allowed to ripen the pests will quickly spread to new host trees. Where the centres of infection are jungle, or wayside trees, some difficulty may be experienced in preventing infections of plantations and orchards but much may be done by frequent inspection and early treatment to prevent seedlings of the parasites establishing themselves and causing material damage. Further it has been shown that the commonest local species of *Loranthus* and *Elytranthe* readily reproduce themselves on individual trees by means of long surface 'runners', so that this is another reason why the parasites should be removed before they become firmly established and cause extensive damage.

To remove mistletoes effectively the smaller branches of infested trees should be pruned back 3 to 4 inches below the points of attack; this in the case of the species with long 'runners' would imply removal below any point where the haustoria had entered a branch. To prune, or pull off, the mistletoes is of little value as new shoots quickly develope from the haustoria embedded in the tissues of the branches.

With reference to the question whether the parasites can be removed from large branches or stems without fatal injury to the host trees, it may be of interest to mention that Bray [6] states that in the case of the American mistletoe (*Phoradendron flavescens*) that plants of this were shaved off close to the bark and painted with carbolineum with the result that after 14 months no fresh growth appeared, also that his experiments seemed to indicate that a strong preservative such as wood-creosote, or carbolineum, could be applied in sufficient quantity to kill the mistletoe without seriously injuring the branch or trunk. Whilst this method may be useful in the case of a valuable fruit tree when it is desired to retain a particular branch, or branches, yet it would appear to be of doubtful value, for example on a rubber plantation where judicious pruning in the manner described above is the treatment indicated. However, when a tree has become very heavily infested and weakened, it may be questioned whether any method of dealing with the parasite, or parasites, would eventually lead to the restoration of the tree's former vigour and usefulness.

Summary.

1. Mistletoes are shown to be common, and often serious pests of cultivated trees in Malaya. The destructive species belong to the genera *Loranthus*, *Elytranthe* and *Viscum*.

2. A short account of the biology and life history of the parasites is included. It is pointed out that the pests are dispersed chiefly by birds which feed on the succulent berries, and further that the species of *Loranthus* and *Elytranthe* described, readily reproduce

themselves vegetatively on individual trees by means of long surface root-runners.

3. It shown that certain species readily parasitize each other.

4. Descriptions of the five chief pests of cultivated trees, namely *Loranthus ferrugineus*, *L. pentandrus*, *L. grandifrons*, *L. pentapetalus* and *Elytranthe globosa* are given, together with a list of names of the trees on which each species has been found. Notes are also included on two other species of *Elytranthe* and two species of *Viscum* which are of less importance.

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PLATES.

Plate 1, Fig. 1 - *Loranthus ferrugineus, Roxb,* at right on a way-side tree the Ara Perak. (*Ficus alba, Reinw.*)

„ Fig. 2 - *Viscum orientale, Wild,* on a branch of Albizzia moluccana, Miq. Note absence of secondary surface root-runners.

Plate 2, Fig. 3 - *Elytranthe globosa, G. Don.* growing on rubber (*Hevea brasiliensis, Muell.*)

„ Fig. 4 - The chief species attacking rubber (*Hevea brasiliensis Muell*),

(A) Young plant of *Loranthus pentandrus, L.* with leaves removed.

(B) A secondary root-runner of *L. pentandrus* with shoots, (leaves removed). Note the large masses of hypertrophied tissue where haustoria enter host.

(C) Secondary roots and shoots (leaves removed) of *Elytranthe globosa, G. Don.* Places where haustoria enter branch of host are only slightly swollen.

Plate 3, Fig. 5 - Hyperparasitism. (A) Branch of *Elytranthe Barnesii, Gamble.* with (B) a young plant of *Loranthus ferrugineus, Roxb.* and (C) (C) two small plants of *Viscum articulatum, Burm.*

„ Fig. 6 - Hyper-parasitism—(A) Branch of *Elytranthe Barnesii, Gamble.* on which is growing (B) *Viscum articulatum, Burm.* and on the latter is (C) a strong plant of *Loranthus ferrugineus, Roxb.*

Page 78 para 4, add.

It would appear however that the original tests were carried out in the U.S.A. and the tests on the stored samples were carried out in England. The different conditions may account for the superior results shewn for the samples after storage.

in America, and elsewhere. The figures given in his reply however do not appear convincingly favourable to latex paper when compared to similar results quoted for non-latex papers, especially in regard to durability tests.

The deterioration on storage appears to be not less in the case of the latex papers than in the case of the non-latex papers.

The folding tests in all cases shew appreciable deterioration in the case of both latex and non-latex papers with no advantage to the former.

The bursting strength in both cases generally increases on storage, which appears somewhat unexpected, although the increases are comparatively as much in favour of the non-latex papers as of the latex papers.

The mean breaking lengths both before and after storage are somewhat in favour of the latex papers, while the breaking strains are slightly in favour of the latex papers.

The report contained in this journal on investigations carried out in The Chemical Division of the Department of Agriculture at the request of the Honourable the Chief Secretary to Government deals with various samples of paper received from the Government Printing Department and other samples obtained locally. Although it was not possible in every case to examine comparative samples, i. e. papers manufactured in a similar manner and containing similar constituents, apart from latex or rubber content, the results obtained, especially in the accelerated ageing tests, confirm those which have been published by other investigators and shew that, as far as these samples are concerned, the presence of latex in the paper does not appear to render the paper less susceptible to deterioration than papers which contain no latex.

Unfortunately, owing to lack of paper testing apparatus it was not possible to carry out complete physical tests on the samples.

In our opinion the application of latex to the manufacture of paper does not appear to hold any very definite promise of success in respect of its utility, either for ordinary purposes or in the case of papers for documents which have to be stored, unless the application of latex lowers the cost of manufacture. The application of latex to pulp in the manufacture of paper does appear to improve the surface for printing purposes, but it is probable that the demand for latex paper on account of this factor would be limited.

It seems probable however that the application of latex to the manufacture of latex boards for containers and other purposes, in which ordinary paper boards or cardboards are used, offers more promising possibilities. The vulcanisation of such mixtures of rubber (added in the form of latex) and pulp, after conversion into latex board will also probably increase the utility and applications of rubber for such purposes.

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A REPORT ON THE COMPRISON OF CERTAIN "LATEX" & "NON-LATEX" PAPERS.

By J. H. Dennett.

COMPARATIVE tests were carried out on a collection of samples of paper which had been selected by the Printing Department as likely to prove suitable for use for general purposes.

Description of Samples.

1. *Control.*—A Millbourne & Company's hand made paper. Cream laid and fairly smooth to the touch. Supplied by Printing Department.

2. *Kayes Latex Paper.*—A Millbourne & Company's hand made Kayelatex. Very slightly darker in colour, smooth to the touch but rather less so than control. Supplied by Printing Department.

3. *Stock Latex Paper.*—An almost dead white paper, very smooth to the touch, but considerably thinner than 1 and 2 above. No water marking. From appearance by transmitted light, probably machine made. Supplied by Printing Department.

4. *W. Howard & Sons Marked " A".*—A cream paper with colour rather unevenly distributed. Shows uneven texture when viewed by transmitted light. Rough to the touch. Supplied by Printing Department.

5. *W. Howard & Sons Marked " B".*—An almost dead white paper exactly similar in feel and texture to "A" above. Samples 4 and 5 said to be identical except that one contains latex. Supplied by Printing Department.*

6. *Java Latex Paper.*—Smooth finish but somewhat uneven in texture by transmitted light. Pale cream in colour. Obtained from a Dutch Paper Mill in Java.

7. *Java 100 per cent Straw.*—Made from the Straw refuse of the padi fields. Similar in texture to 6 above but rather lighter in colour. Obtained from a Dutch Paper Mill in Java.

8. *Latex Correspondence Pad.*—Bedford Bond water-mark. Ivory white in colour. Even in machine but a little rough to the touch. Obtained from Federal Rubber Stamp Company, Kuala Lumpur.

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* It appeared from a chemical test that the sample of Howard's paper which contained latex was sample "B."

Testing.—The general testing of paper is a rather lengthy process involving chemical and physical tests. The latter for general purposes are of greater importance.

The most important physical properties to be examined are :—

(*a*) Folding properties

(*b*) Breaking strain and tensile strength

(*c*) Bursting strain

(*d*) Breaking length

(a) *Folding Properties.*—Owing to lack of the suitable apparatus it has been necessary to examine the folding properties by hand. The figures are given in table VI. The figures given for elongation at break (Table I) should to some extent be indicative of the folding properties.

(b) *Breaking strain and tensile strength.*—These are determined together. The former being the actual force required to break a given paper of some known width irrespective of its thickness, while tensile strength is a measure of the strength of any given paper taking into consideration the thickness of the sample.

(c) *Bursting Strain.*—No suitable apparatus was available for bursting tests.

The following tables give the results obtained for breaking strain and tensile strength of the above papers.

The figures may be taken as some indication of the tearability of the paper.

The samples were broken in Schopper's Rubber Testing Machine, which automatically records the force required to break any piece of paper clamped between the jaws.

Strips were made 2.54 centimetres (1") wide and were of sufficient length to allow of the initial distance between the jaws (after insertion of the strip) to be 10 centimetres.

The samples described gave the results recorded in Table I.

TABLE I.

Papers.	Across the Machine.						With the Machine.					
	Number of strips tested	Mean thickness of strips Millimetres.	Number of readings to obtain mean thickness	Breaking force in Kilograms.	Breaking force per sq. Millimetre Cross section (in grams)	Elongation at break per cent.	Number of strips tested.	Mean thickness of strips in Millimetres.	Number of readings to obtain mean thickness.	Breaking force in Kilograms.	Breaking force per sq. Millimetre Cross section (in grams)	Elongation at break per cent.
1. Control ...	12	0.1398	122	10.74	3026	9.1	6	0.1360	114	12.50	3622	7.3
2. Kayes ...	12	0.1465	123	10.05	2701	7.0	12	0.1452	153	13.52	3668	7.0
3. Stock latex ...	14	0.1024	140	3.30	1267	4.4	14	0.0978	121	6.32	2545	2.8
4. Howards "A" .	12	0.1880	128	7.01	1468	7.0	12	0.1877	113	11.08	2324	5.2
5. Howards "B" ...	12	0.1785	134	7.65	1687	8.0	12	0.1788	123	11.80	2598	6.2
6. Java latex ...	10	0.1019	120	5.21	2013	7.0	12	0.1022	142	10.99	4235	4.2
7. Java straw ..	10	0.1416	126	7.29	2025	10.5	10	0.1419	87	12.01	3280	5.2
8. Corr. pad latex ...	9	0.1200	94	5.25	1722	6.6	7	0.1202	135	10.25	3368	4.2

Note :—These figures although comparable amongst themselves are not directly comparable with similar figures obtained on papers tested in countries having a dissimilar atmospheric humidity.

It will be noticed that there is a marked difference between the tensile properties of the paper according to the direction of rupture. With a machine made paper there is a definite grain, which will exert an influence in resisting or yielding to a breaking strain according to the direction of application of the force. The action is comparable to the behaviour of the "chick" blind when loaded from the bottom in one case or when loaded in the other case from a direction at right angles to the normal hanging position. It will be evident that a much greater force will be required to break the chick in one direction than in the other.

For general purposes, to obtain average values for breaking force it is conventional to take the mean of the break with the machine, and, across the machine.

In the following table the papers are arranged in the order:—

A. Of their break across the machine

B. Of their break with the machine

C. Of their mean break.

TABLE II.

A Across machine	Breaking force in Kilograms.	B With machine.	Breaking force in Kilograms.	C Mean.	Mean breaking force in Kilograms.
Control	10.71	Kaye	13.52	Kaye	11.78
Kaye	10.05	Control	12.52	Control	11.62
Howards B	7.65	Java straw	12.50	Howards B	9.92
Java straw	7.29	Howards B	11.01	Java strew	9.65
Howards A	7.01	Howards A	11.80	Howards A	9.01
Corr: Pad latex	5.25	Java latex	10.08	Java latex	8.10
Java latex	5.21	Corr: Pad latex	10.99	Corr: Pad latex	7.75
Stock latex	3.30	Stock latex	6.32	Stock latex	4.81

If the papers are arranged in descending order corresponding to the figures obtained for their tensile strengths recorded "across the machine," "with the machine" and the mean of "across" and "with the machine" the samples examined appear as arranged in Table III.

TABLE III.

Cross	Tensile strength grms. per sq.millimetre.	Machine	Tensile strength grms. per sq.millimetre.	Mean	Tensile strength grms. per sq.millimetre.
Control	3026	Java latex	4235	Control	3321
Kaye	2701	Kaye	3668	Kaye	3185
Java straw	2025	Control	3622	Java latex	3124
Java latex	2013	Corr. Pad (latex)	3368	Java straw	2652
Corr. Pad Latex	1722	Java straw	3280	Corr. Pad (latex)	2515
Howards B Latex	1687	Howards B (latex)	2598	Howards B (latex)	2142
Howards A	1468	Stock latex	2515	Stock latex	1906
Stock latex	1267	Howards A	2321	Howards A	1896

The difference between Tables II and III will be appreciated when it is remembered that table II only gives a comparison of the papers irrespective of their thickness while table III gives a truer scientific comparison of the value of the papers, as in the results recorded the figures have been reduced to a basis of 1 sq. millimetres cross section.

(c) *Breaking length.*– This may be described as the length of paper, which if suspended from one end would break at the point of suspension by reason of its own weight. The convenience of this expression lies in the fact that it is entirely independent of the width of the strip.

From the breaking forces obtained in Table I the following. breaking lengths have been calculated. They are arranged in descending order of magnitude.

TABLE IV.

Paper.		Mean weight per sq. metre in grms.	Mean breaking length in metres.
Kaye	...	106.9	434
Control	...	107 0	428
Corr Pad latex	...	79.1	387
Java Latex	...	83 75	382
Java Straw	...	110 5	341
Howards B	...	131.9	297
Howards A	...	131.0	272
Stock latex	...	81 6	232

Table V gives the proportion of mineral-matter per cent found in the papers. The results are arranged in order of magnitude.

TABLE V.

Paper.		Per cent Mineral Matter.
Control	...	1.0
Kaye	..	1.7
Java latex	...	5 2
Howards B (latex)	...	5 5
Howards A	...	6.0
Java straw	...	11.0
Stock latex	...	14.0

The figures are to a large extent indicative of the loading matter in the papers and to some extent account for the difference in the properties.

OBSERVATIONS.

From the various tables set out above it would appear that Kayes Latex Paper has about the same general value as a similar paper (control) without latex. The mean breaking force is slightly higher than that of the control, as is also the breaking length. On the other hand the mean tensile strength is slightly lower than the control. Java Latex Paper is better than the similar all-straw paper.

Howards B (latex) is superior throughout to Howards A.

The stock latex paper is very poor compared with all the others, due largely no doubt to its much heavier "loading" as shewn by the ash.

Ageing Tests.

In the further tests described below, another sample of latex paper has been tested in place of (8) and in this report is designated as "Kalatex." This is a machine made paper, very smooth to the touch and rather thinner than (2).

The conditions under which the samples were aged were as follows :—

(a) Samples wrapped in brown paper and stored in a cupboard for 5 months.

(b) Samples stored in glass stoppered bottles, freely exposed to diffused light at room temperature (about 28°C) for five months.

(c) Samples stored in glass stoppered bottles in an oven, heated by boiling water. Heating continued for 6 hours daily for five months.

(d) Samples stored in glass stoppered bottles and exposed to direct sunlight for 8 hours daily for 5 months.

The samples were under the influence of atmospheric moisture throughout.

The following observations are offered under the headings (b) c) and (d).

(b) In this case a general yellowing effect was observed, more noticeable in some samples than in others.

The order of their resistance to yellowing is as follows ;—

Control.

Kayes.

W. Howards "B"

Kalatex.

100% Straw.

Stock Latex.

W. Howards sample "A" (yellowish at commencement)

Java Latex. .

(c) No change was observed generally in the samples kept in the laboratory except samples 2., 4. and 8 which shewed a very slight bleaching compared with the samples stored under conditions (a)

(d) A general bleaching effect was observed, this was particularly noticeable with regard te sample (4).

Folding Properties.

The folding properties were determined by two methods; (i) by machine after storage under conditions (b) above (ii) by hand before storage.

(i) *By-machine.* No proper folding machine was available. The method adopted was as follows. Six pieces of paper 6" square were cut from each of the samples under examination. Three pieces of each batch of six were carefully folded along the length, down the centre of the paper. The other three were folded in a similar manner along the breadth. The papers were then passed through the upper rolls of a rubber calendering machine. As they came out the papers were folded back along the same line and again passed through the rolls. The process was repeated until the paper was broken completely into two halves along the line of fold. It will be realised that by this means the papers were broken much quicker than by hand.

(ii) *By hand.*– This method has but little scientific value as the personal error is very great.

The following table shows the results. The figures are the mean of three pieces, across, and with the machine.

Table VI.

Paper.		By rollers (after ageing under) conditions (b)	By hand (Before ageing.)
Kayes Latex	...	44	257
Control	...	33	246
Kalatex	...	28	*
Howards "B"	...	16	213
Stock Latex	...	16	60
Java Latex	...	14	167
Howards "A"	...	10	235
Java Straw	...	8	121

While results by these two methods are only in very general agreement it will be seen that latex paper appears to be superior in this respect to the corresponding ordinary paper, Kayes Latex and Control (2) Howards "B" and Howards "A" (3) Java latex and Java Straw. For stock latex and Kalatax, there are no comparable non-latex papers.

Breaking Strain and Tensile Strength.

The samples, stored as described under (a) (b) (c) & (d), were all tested for breaking strain and tensile strength.

The breaking strain and tensile strength are given in Table VII.

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* This paper was received too late to be tested with the others. Results obtained by two persons being incomparable.

TABLE VII.

Paper.		Across the Machine.					With the Machine.				
		Mean thickness of strips Millimetres.	Number of readings to obtain mean thickness.	Breaking force in Kilograms	Breaking force per sq. Millimetres cross section (in grams).	Elongation at break per cent.	Mean thickness of strips Millimetres.	Number of readings to obtain mean thickness.	Breaking force in Kilograms	Breaking force per sq. Millimetres cross section (in grams).	Elongation at break per cent.
Control	a	0.147	41	12.60	3370	3.6	0.141	47	12.60	3515	3.7
„	b	0.138	43	11.93	3400	3.6	0.138	50	14.77	4210	3.6
„	c	0.135	47	10.57	3079	3.7	0.140	50	12.72	3633	3.5
„	d	0.148	43	7.57	2015	3.1	0.151	53	9.52	2480	3.5
Kayes	a	0.146	64	11.97	3228	2.5	0.150	68	13.24	3479	3.9
„	b	0.142	164	10.26	3009	3.3	0.138	98	14.65	4185	3.6
„	c	0.146	86	10.54	2850	3.5	0.143	100	10.77	2967	3.5
„	d	0.141	95	6.48	1808	3.4	0.142	88	8.08	2240	3.7
Stock Latex	a	0.095	56	3.40	1406	2.9	0.095	53	5.52	2287	2.2
„	b	0.093	59	2.05	868	2.6	0.093	60	6.40	2709	2.2
„	c	0.091	60	1.95	845	2.2	0.092	55	2.35	1070	2.2
„	d	0.095	61	3.17	1311	3.4	0.095	59	4.32	1793	2.1
Howards "A"	a	0.170	60	8.15	1890	3.7	0.176	58	13.65	3053	3.6
„	b	0.171	48	8.12	1870	3.4	0.171	56	12.32	2835	3.1
„	c	0.167	60	7.20	1697	3.0	0.170	56	10.42	2412	3.1
„	d	0.169	54	6.97	1624	2.9	0.171	54	10.05	2315	3.4

a = in dark, b = in laboratory. c = in oven. d = in sun.

TABLE VII—(*contd*).

Paper.		Across the Machine.					With the Machine.				
		Mean thickness of strips Milli-metres.	Number of readings to obtain mean thickness.	Breaking force in Kilograms	Breaking force per sq. Millimetres cross section (in grams).	Elongation at break per cent.	Mean thickness of strips Milli-metres.	Number of readings to obtain mean thickness.	Breaking force in Kilograms	Breaking force per sq. Millimetres cross section (in grams).	Elongation at break per cent.
Howards "B"	a	0.154	58	6.87	1760	4.0	0.158	60	11.27	2808	3.3
,,	b	0.160	48	7.40	1822	4.1	0.158	66	10.62	2650	3.5
,,	c	0.156	56	6.17	1556	3.1	0.156	60	7.72	1949	2.9
,,	d	0.160	54	5.60	1379	2.9	0 156	54	5.60	1413	2.9
Java Latex	a	0.090	53	5.07	2220	3.2	0.090	47	7.65	3346	2.6
,,	b	0.090	53	4 47	1955	3.0	0.090	58	8.60	3805	2.7
,,	c	0.085	62	2.77	1281	2.6	0.087	54	3.87	1751	2.7
,,	d	0.090	61	2.62	1147	3.1	0.092	54	3.20	1249	2.6
100% Straw	a	0.134	65	5.80	1704	4 5	0.135	50	12.62	3680	3.9
,,	b	0.132	54	6.55	1923	4.4	0.132	53	11.52	3436	3.4
,,	c	0.130	46	4.62	1396	3.4	0 131	58	8.52	2567	3.2
,,	d	0.132	54	6.37	1896	4.2	0.132	51	9.07	2674	4.0
Kalatex	a	0.099	51	4.14	1649	3.6	0.100	56	6.97	2744	2.9
,,	b	0.100	60	4.60	1811	3.4	0.100	64	7 1	2795	2.6
,,	c	0.100	47	3 25	1283	2.9	0.100	57	5.92	2330	2.5
,,	d	0.100	59	3 37	1366	3.4	0 100	53	5.62	2212	3.1

a = in dark. b = in laboratory. c = in oven. d = in sun.

In these tests the strips were again cut to a with of 2.54 cms. but in this instance the conditions of ageing rendered it necessary to make the initial distance between the jaws of the testing machine 7 centimeters.

It will be noted (Table VII) that there is again a large difference between the break with the machine and the break across the machine.

This table shews the great changes which have taken place in the paper on exposure to excessive light and heat.

For the most part the greatest deterioration appears to have taken place on exposure to the sun, exposure to heat only, having a rather less marked effect.

In Table VIII the papers are arranged in the order of their mean breaking strains across and with the machine, while in column 3, 4 and 5 will be found the percentage decrease in mean breaking strain on exposure to laboratory, oven and to the sun respectively.

TABLE VIII.

Paper	Mean breaking force under condition (a) Kilograms.	Mean per cent deterioration of breaking strain under condition. (b)	(c)	(d)
Control	12.60	– 5.95	ƒ 6.82	ƒ 32.27
Kayes	12.60	ƒ 1.19	ƒ 15.48	ƒ 42.20
Howards "A"	10.90	ƒ 6.25	ƒ 19.18	ƒ 26.50
Java Straw	8.21	ƒ 1.95	ƒ 28.65	ƒ 16.17
Howards "B"	9.07	ƒ 0.66	ƒ 23.40	ƒ 38.20
Jawa Latex	6.86	– 2.67	ƒ 48.00	ƒ 55.60
Kalatex	5.56	– 4.31	ƒ 17.61	ƒ 19.45
Stock Latex	4.46	ƒ 5.88	ƒ 51.75	ƒ 16.03

– Represents an increase as compared with condition (a)

ƒ Represents a decrease as compared with conditions (a)

It appears throughout table VIII that latex paper does not withstand the action of heat and light so well as the non-latex paper varieties. These figures apply only to the particular papers tested and not to the type of pulp from which they are manufactured.

Table IX corresponds to table VIII with the substitution of the tensile strength of the paper in place of breaking force, and the percentage deterioration of the tensile strength on exposure to laboratory heat and to the sun, in place of percentage deterioration of the breaking force. The essential of the table of tensile strength is that the figures apply to any sheet of paper made from the same pulp irrespective of its thickness.

Fig, I.

Fig. II.

PLATE II.

Fig. III

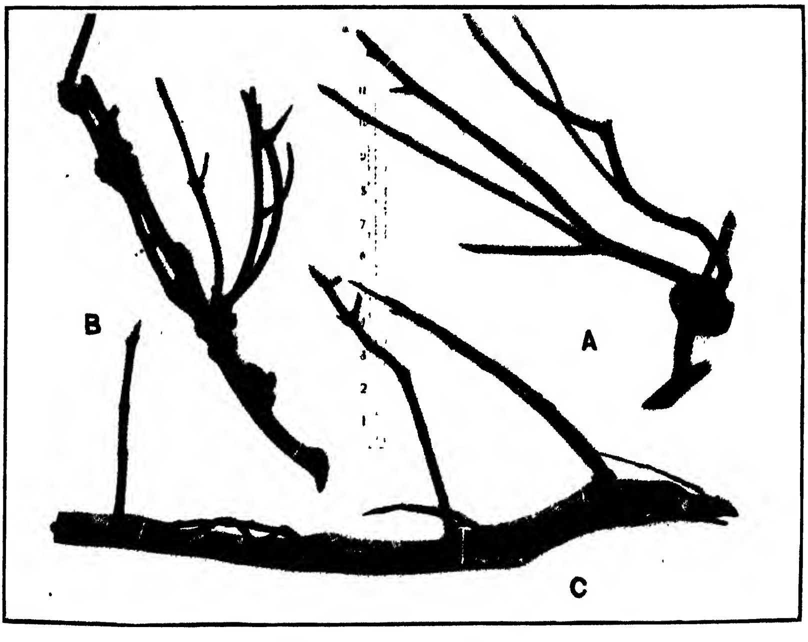

Fig. IV.

PLATE III.

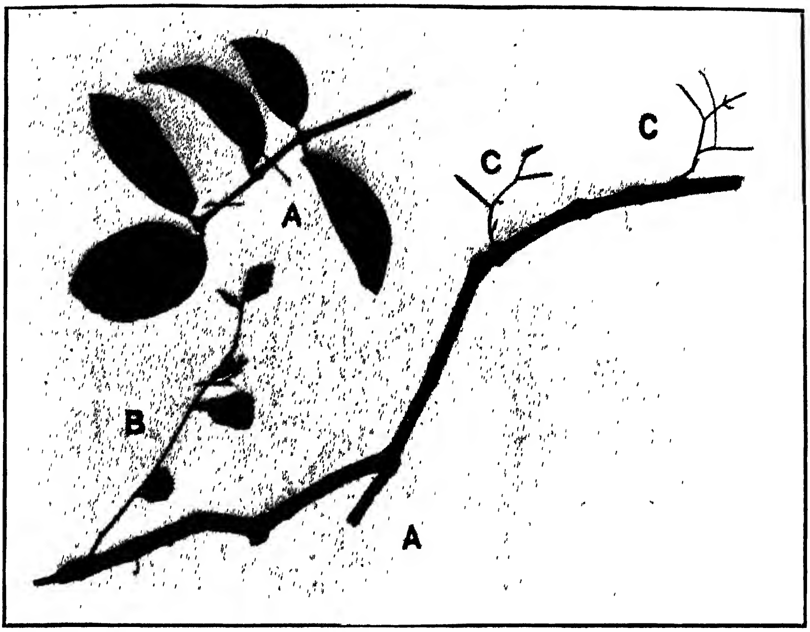

Fig. V.

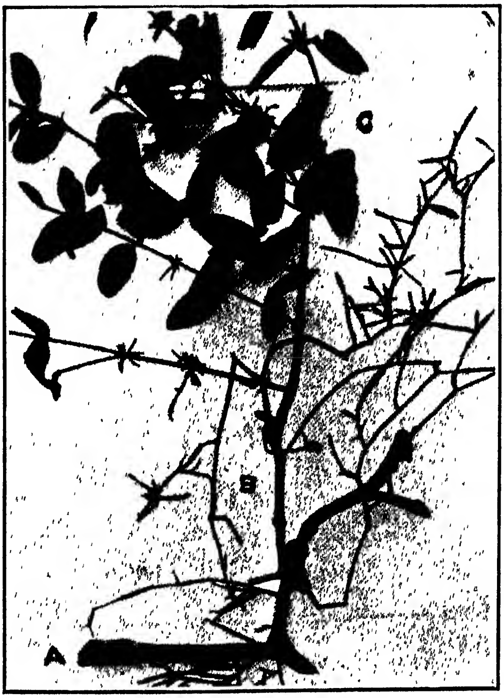

Fig. VI.

ILLIPE NUTS AND BORNEO TALLOW.

By C. D. V. Georgi.

DURING the past two years several samples of the fat expressed from Illipe nuts have been examined, and it has been thought that it might be useful to record the results of the investigations, especially in view of the confusion which exists as to the name Illipe and the uncertainty regarding the botanical name of the trees from which the nuts are obtained.

The confusion regarding the name Illipe is due to the fact that this name is applied to two distinct nuts, the true Illipe nut of India, a species of *Bassia* (Natural Order, Sapotaceae) and the so-called Illipe nuts found in this country, Borneo, Sumatra and Java, derived from various species, principally *Shorea* (Natural Order, Dipterocarpeae). There is however one kind of local Illipe nut, prefixed by the name Siak, which belongs to the same Natural Order as the true Illipe nut of India, but is a different species, namely *Palaquium*.

The uncertainty regarding the botanical names for the trees, from which the nuts are obtained, arises from the fact that these trees are scattered over wide areas of jungle. The collection of the nuts is a native industry, and in many cases it has not therefore been possible to establish the identity of the various trees. There are at present no plantations of these trees and it does not appear likely that any attempts will be made in this direction, as the trees take several years to come into bearing and the yield is variable.

The fat expressed from these local Illipe nuts is known commercially as Borneo tallow, this name being derived doubtless from the original country from which the fat was obtained, and from the resemblance which the fat itself bears to tallow as regards consistency.

The fat is known by the Malays as Minyak Tengkawang, variations of the latter name such as Tinkawan, Tengkawan and Sengkawang being also found.

Harvesting of Fruits.

As stated above, the cultivation of various trees yielding these nuts has never been undertaken systematically, so that there is practically no information available as to growth and period of maturity. As far as is known the trees do not commence bearing fruit until 10 or 12 years old, and the yield is uncertain. The trees flower towards the end of the dry season, August-September, and the fruits are ready for gathering during February-March of the following year. The fruiting appears to be dependent on the weather prevailing at the time of flowering; if the flowers set well before the advent of the wet season there is every chance of a good crop but, if the flowering coincides with the break in the weather, the crop will suffer.

The fruits fall when ripe and and are collected by the natives who shell them; only the kernels are exported and constitute the so-called Illipe nuts of commerce.

The shell of the nut is somewhat tough and the natives resort to various methods to facilitate its removal. In some cases the fruits are packed into a bamboo basket or cage and sunk in a river or stream

for a few weeks. In this way the shell becomes soft and can be removed easily, after which the kernels are dried.

Another method which would appear to be favoured by the natives is to heap the nuts in a damp place and allow them to germinate. The shells are then removed and the kernels dried. Frequently portions of sprouts are found with the kernels indicating that this method of separation has been employed.

Export of Nuts.

Little Borneo tallow is produced locally, the nuts being exported and expressed in Europe. A large proportion of the Illipe nut trade passes through Singapore; the figures in the following table compiled from the returns published by the Registrar of Imports and Exports Straits Settlements are of interest in this respect.

Imports.

Year.	Quantity (piculs).	Value $	Remarks.
1921	16,365	80,319	
1922	15,115	104,409	647 piculs from British Possessions and Protectorates, 14,468 piculs from other countries.
1923 (½ year)	222,037	2,341,413	118,079 piculs from British Possessions and Protectorates, 103,958 piculs from other countries.

Exports.

Year.	Quantity (piculs).	Value ($)	Remarks.
1921	7,561	39,496	
1922	30,125	258,616	4276 piculs to United Kingdom, 25,750 piculs to Continent of Europe, 99 piculs to other countries.
1923 (½ year)	146,033	1,873,379	43,742 piculs to United Kingdom, 102,253 piculs to Continent of Europe, 28 piculs to other countries.

Varieties of Nuts Examined.

In general the kernels yielding the so-called Borneo tallow of commerce are placed on the market as Illipe nuts, to which is prefixed the name of a district or town in Borneo e.g. Pontianak. In addition to this prefix the nuts are distinguished by their colour, black or brown and sometimes by their size, large or small, thus there are large brown Pontianak Illipe nuts and small Pontianak Illipe nuts. The difference in colour appears to be due to the treatment which the nuts undergo when being prepared for the market, though it is stated that those which are black in colour are the nuts which have remained on the damp ground or in jungle streams for some time before collection and have blackened naturally.

Messrs. Paterson Simons & Co. Ltd., who are the principal dealers in these nuts in Singapore, have furnished this Department very kindly with samples of the following varieties under their trade names, all of which samples have been examined:

Large Sarawak Illipe Nuts.

Small Sarawak Illipe Nuts.

Large Siak Illipe Nuts.

Small Siak Illipe Nuts.

Large Black Pontianak Illipe Nuts.

Large Brown Pontianak Illipe Nuts.

Small Pontianak Illipe Nuts.

In addition authentic specimens from one of the *Shorea* species, *Shorea Thiseltoni*, were obtained through the kindness of Dr. F. W. Foxworthy, Forest Research Officer, F.M.S., who also furnished a sample of the fat expressed from another species, *Isoptera borneensis*. These samples were also examined.

Description of Nuts.

(1) *Large Sarawak Illipe Nuts.*—These consisted of the segments into which the kernels separate on drying. The segments were approximately triangular in cross-section, dark brown in colour and curved longitudinally. They varied somewhat as regards length, being between 1.5 ins. and 2 ins. long.

(2) *Small Sarawak Illipe Nuts.*—These consisted almost entirely of whole nuts, though in some cases the latter had split up into segments. The nuts were dark brown in colour, pointed at one end and curved longitudinally. There appeared to be little variation as regards size, the average length being approximately ¾ inch.

(3) *Large Siak Illipe Nuts.*—These consisted partly of whole nuts and partly of half nuts, as distinct from the segments into which the Sarawak nuts were divided. In some cases the kernels were covered with a thin light brown skin. The kernels themselves were dark brown in colour and flat in shape, the dimensions varied slightly, the average being about 1¼—1½ ins. long and ½ inch in breath.

(4) *Small Siak Illipe Nuts.* These consisted almost entirely of whole nuts, though a few were in halves similar to the large ones. As in the case of the large nuts some of the kernels were covered with a thin brown skin. The kernels were egg-shaped and dark brown in colour. The dimensions varied slightly, the average being about ¾ inch long and rather less than ½ inch in breadth.

(5) *Large Black Pontianak Illipe Nuts.*—These were similar to the large Sarawak, except that the colour was darker and the segments were curved to a greater extent.

(6) *Large Brown Pontianak Illipe Nuts.* These again were similar to the large Sarawak except that they were of lighter colour and the dimensions of the segments were smaller, the average length being only slightly over 1 inch.

(7) *Small Pontianak Illipe Nuts.*—These were similar in size and colour to the small Sarawak Nuts.

(8) *Shorea Thiseltoni Nuts.* The nut consisted of a thin fibrous brownish yellow shell enclosing a soft light green kernel. In some cases portions of the winged calices still remained attached to the nuts. The kernels were pointed at one end and were slightly under 1 inch in length and about ⅝ inch in breath.

Examination of Fats.

In order to obtain a sufficient quantity of the fat for the determination of the physical and chemical constants, the kernels were picked over carefully to remove pieces of broken shell and other debris, and then crushed between rollers to a fine state of division. The sample for the determination of the fat content was withdrawn, and the remainder pressed hot in a small laboratory hand press.

The colours of the fats thus expressed varied only slightly, from a pale yellow to yellowish green, the fats from the Siak varieties were however almost white. It may be mentioned that the colours of these fats fade on exposure to light, so that after a short time the differences in colour between the Siak and other varieties would be still less marked. It was also noticed that although the fats could all be classed as of a firm consistency, those derived from the Sarawak and Pontianak varieties of nuts were harder than those from the Siak, All the samples possessed a faint odour resembling that of Cacao butter.

The results of analysis are shown in table A :

TABLE A.—TABLE SHOWING THE RESULTS OF ANALYSIS OF VARIOUS KINDS OF ILLIPE NUTS.

Kind of Nuts.	Large Sarawak.	Small Sarawak.	Large Siak.	Small Siak.	Large Black Pontianak.	Large Brown Pontianak.	Small Pontianak.	Shorea Thiseltoni.	Isoptera borneensis.
ANALYSIS OF NUT (parts per cent).									
Moisture	6.4	8.0	7.1	5.7	6.3	6.3	7.3	34.8	...
Fat	50.9	41.8	47.7	55.8	59.1	48.4	42.4	19.5	..
Residue (by difference)	42.7	50.2	45.2	38.5	34.6	45.3	50.3	45.7	...
CONSTANTS. FAT.									
Melting Point	...	...	...	...	...	...	...	37—38°C	37—38°C
Density at 100°C (water at 15.5°C = 1)	...	...	...	...	...	...	...	0.857	0.861
Saponification value[1]	192.5	191.7	189.4	181.6	191.6	193.0	192.2	192.2	191.7
Acidity (Stearic acid per cent) ...	10.3	6.4	15.2	18.6	13.1	5.0	8.1	1.0	1.0
Unsaponifiable (per cent) ...	0.6	0.9	1.0	6.4	0.8	0.7	0.7	1.1	...
FATTY ACIDS.									
Solidifying Point (Titer value) ...	55°C	55.1°C	58.1°C	57.4°C	53.3°C	52°C	52.7°C	51.5°C	48.9°C
Mean Molecular weight	280.0	286.5	288.4	302.0	282.9	282.6	283.8	285.8	297.1

[1] Milligrammes of potash for 1 grammes of fat.

With regard to the fat contents of the various samples of nuts it will be seen that there are considerable variations even among those samples which differ only in colour, as for example large black Pontianak and large brown Pontianak.

The constants of the fats, with the exception of the acidity figures, vary only within relatively narrow limits, except that the high percentage of unsaponifiable matter in the fat from the small Siak variety (this affects both the saponification value and the mean molecular weight of the fatty acids) is particularly noticeable.

The high acid values of the commercial samples are undoubtedly due to the manner in which the kernels are prepared for the market, though, if the nuts were left lying about for some time in the jungle before collection, fermentation would set in, which would also tend to increase the acidity of the fat. It will be noticed that in the case of the two samples supplied by the Forest Department, in which the nuts were collected carefully, the fat was almost neutral.

Uses of Borneo Tallow.

While small quantities of these fats are used by natives for edible purposes, particularly in cases where there are religious objections to the use of animal facts, the value of Borneo tallow lies in the application which it finds in Europe as an edible fat, especially in the preparation of chocolate for eating purposes. Borneo tallow closely resembles Cacao butter in its analytical constants and on this account can be employed as a substitute.

The following table illustrates the resemblance between these two facts, the figures for Cacao butter being taken from Lewkowitsch "Chemical Technology and Analysis of Oils, Fats and Waxes" Fourth Edition, Vol. II pages 480 and 481, those for Borneo tallow being taken from the table previously given.

		Cacao butter	Borneo tallow
Fat.			
Density at 100°C (water at 15.5°C = 1)	...	0.8577	0.861
Melting Point	...	28-33°C	37-38°C
Saponification value[1]	...	191.8-194.5	191.7
Iodine value	...	34.7-37	29.9
Fatty Acids.			
Solidifying Point (Titer value)	...	49.6°C	48.9°C

Smaller quantities of Borneo tallow are used in the manufacture of soaps and candles. Messrs. Paterson Simons & Co. state that the Sarawak and Pontianak varieties are used almost exclusively for edible purposes, whereas the Siak varieties are employed in soap-making.

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[1] Milligrammes of potash for 1 gramme of fat.

LEMONGRASS OIL.

By C. D. V. Georgi.

LEMONGRASS, a grass similar in appearance to Citronella, is found distributed throughout Malaya, chiefly in small clumps in small holdings and kampongs, where the natives use it to a small extent for culinary purposes.

The grass contains an essential oil, lemongrass oil, for which there is a limited demand and a series of experiments has been carried out to determine the yield of oil from the grass and the value of the oil.

The supply of grass for the experiments was obtained from the Government Experimental Plantation, Serdang, where small areas of this crop are under cultivation.

In spite of the fact that there appears to be little demand for this oil at present, it is thought that the publication of the results of this investigation will be of interest.

Varieties of Grass.

Lemongrass belongs to the genus *Cymbopogon* (Natural order Gramineae) to which natural order other so-called aromatic grasses belong, notably citronella grass which, as is well known, is distilled for its essential oil.*

There are two varieties of lemongrass, known as *Cymbopogon flexuosus*, Stapf and *Cymbopogon citratus*, Stapf. The former variety produces the oil known as "East Indian Lemongrass Oil," which differs from that obtained from the *C. citratus*, Stapf in respect of solubility in 70 per cent. alcohol. The genuine "East Indian Lemongrass oil" is soluble in 1.5 to 3 vols. of 70 per cent. alcohol, while the oil from *C. citratus*, Stapf gives a turbid solution with this strength of alcohol.

The oil from *C. citratus*, Stapf, is referred to occasionally as "West Indian Lemongrass oil." This name was adopted before the botanical identity of the grass had been established, and was used to distinguish an oil which gave a turbid solution with 70 per cent. alcohol. Moreover at that time the greater proportion of such oil came from the West Indies.

The botanical origin of the local grass is somewhat doubtful, the oil giving a very slight turbidity with 70 per cent. alcohol. A sample of the oil has been judged by a firm of analytical chemists in London

*An article on the subject of Citronella oil entitled "The utilisation of citronella grass planted as a preventive of soil wash" was published in the Malayan Agricultural Journal Vol. XII, No. 1, Jan. 1924.

to be a genuine lemongrass oil of the "East Indian type" but from their report it appears that the solubility test was carried out with 80 per cent. alcohol, in which strength the oil was found to be soluble in the proportion of 1 : 1. The local grass is being identified botanically, and samples are being collected for despatch to the Royal Botanic Gardens, Kew, England.

Cultivation of Grass.

Lemongrass, like citronella requires a hot damp climate and flourishes in this country. If the grass is to be used for the preparation of oil it must be cut frequently, as the oil content diminishes with the age of the leaf. Further, like citronella, the oil output diminishes with the age of the plant, so that if the plant is cultivated on a commercial scale it will be necessary to replant the areas every few years.

Extraction of Oil.

The process by which the oil is extracted from the grass is similar to that described in the article under citronella grass,* that is, a steam distillation of the semi-dried grass.

The details of the process as regards the preliminary treatment of the grass, the steam distillation and the separation of the oil are the same as for citronella.

Yield of Oil.

As a result of the experiments carried out with the grass from Serdang it appears the average yield of oil is about 0.2 per cent. by weight, that is, 1 ton of fresh grass gives about 4 lbs. of oil. The weight of fresh grass per acre when cut regularly is between 4 and 5 tons per acre, so that a yield of 16—20 lbs. of oil per acre per cutting is all that can be expected. Two or sometimes three cuttings a year can be made dependent on the season. If the grass is cut twice a year, this would result in an annual yield of 32—40 lbs. of oil per acre.

Value of Oil.

As a result of the experimental distillation about 6 lbs. of the oil was sent to the Malay States Information Agency, London for valuation.

The results of the chemical analysis as carried out by the firm of analytical chemists were as follows :—

Density at 15.5°C	... 0.902
Citral (Bisulphite process)	... 75/76 per cent.
Solubility in 80% alcohol	... 1 in 1 volume.

*Compare Malayan Agricultural Journal, Vol. XII, No. 1 January 1924.

The oil was pronounced to be a sample of genuine lemongrass oil of the "East Indian type."

Unfortunately at that time (September 1923) the oil was in low demand the nominal value being about $2\frac{3}{8}$d. per oz. spot, at which price there were no buyers. Recently (January 1924) there was a small advance to $2\frac{3}{4}$d. per oz. spot, at which price buyers began to come forward, but even at this price the production of the oil cannot be recommended as a commercial proposition.

Uses of Oil.

As its name implies, lemongrass oil has an intensive lemon-like odour and taste. The oil itself is a dark reddish brown liquid. Apart from the question of solubility in alcohol mentioned above, the characteristic feature of this oil is the citral content, which varies between 70 and 85 per cent. Citral is employed largely in artificial perfumery for the preparation of Ionone, the basis of artificial oil of violets. Smaller quantities of lemongrass oil are used in other perfumes, while in tropical countries this oil is employed as a mosquito preventive, but apart from its application in the preparation of the artificial violet perfume this oil is not of great importance.

Received for publication 31st January, 1924.

MARKETS FOR ESSENTIAL OILS.

TWO enquiries have been received recently from firms interested in essential oils, especially citronella oil and patchouli oil. Both of these products were formerly produced in Malaya from citronella grass and patchouli grown in the country. At the present time there is probably only one distillery for citronella oil in Malaya while the patchouli oil distillers are distilling leaves chiefly derived from the Netherlands East Indies (Sumatra) although an area has been planted in Johore.

Recently the price of citronella oil has risen considerably, the present market value being about 4/9 per lb for "Java" oil which is similar to the oil from the grass grown in Malaya.

The following notes on the packing of these oils have been supplied by one of the firms desirous of purchasing the oils.

Citronella Oil:—This oil can be shipped in iron or steel drums containing upwards of 5 cwt each and should be guaranteed pure and contain not less than 85 per cent of "Geraniol." (The "geraniol" figure indicates the content of the two principal constituents of the oil—geraniol and citronellal.)

Note:—Secondhand oil drums, after having been throughly steamed out, can be used for packing. Kerosene tins packed in crates can also be employed, but each tin would only contain about 35 lbs. of oil. Present price of Java oil 4/9 per lb.

Lemon Grass Oil:—This should be guaranteed pure and contain not less than 75 per cent of Citral. It can be packed in drums, as in the case of Citronella oil. At present however, prices are low owing to over production. Present price 2d. to 2 1/8d. per oz.

Patchouli Oil:—Shippers must be prepared to sell on C.I.F. or C. & F. terms either London or Continent and prices must include packages. Terms of payment C.O.D. after approval.

Notes.—All oils are tested by analytical chemists in London. Care should be taken in selection of containers and gross weight and tare indicated on the containers.

B. J. E. (11-1-24).

NOTES ON THE EXPERIMENTAL PLANTATION, SERDANG FOR THE MONTH OF FEBRUARY, 1924.

THE dry weather experienced during the month has been responsible for the ripening of a number of crops and the following plots were harvested :—Natal Red Top Grass (*Tricholaena rosea*), Dallis Grass (*Paspalum dilatatum*), Carpet Grass (*Axonopus compressus*) and Napier Grass (*Pennisetum purpureum*). With the exception of the first named, which contained too many weeds to be of any value, the wet weight of the grasses was recorded in each case.

Plots of Gingelly (*Sesamum indicum*), Arrowroot (*Maranta arundinacea*) and Roselle Fibre (*Hibiscus Sabdariffa* var. *altissima*) were also harvested. The last named plots were stripped by various methods in order to test which is the most economical.

A Hand/Power Macarthy Cotton Gin has been installed on the plantation and a quantity of the cotton harvested last season was ginned with very satisfactory results.

Considerable trouble has been experienced with night-flying beetles attacking various crops on the plantation, but these pests have been checked by spraying with a solution of Lead arsenate (2 lbs. of lead arsenate to 50 gallons of water) and also by digging the insects from around the collar of the plants.

Rain fell on 21 days during the month giving a total rainfall of 6.69 inches. The heaviest rainfall in 24 hours was 2.28 inches.

The maximum shade temperature recorded was 94°F and the minimum 66°F. The average maximum shade temperature was 90·18°F and the average minimum 69.76°F

Records of the cup-indicating anemometer show that the total run of the wind for the month was 1299.01 miles, the average run for the 12 hours from 6 a.m. to 6 p.m. being 35.16 miles and that from 6 p.m. to 6 a.m. 9.63 miles.

B.B. (10-3-24).

ECONOMIC AND NON-ECONOMIC PLANTING MATERIAL.

PRICE LIST.

Fruit Seedlings.

Avocado Pear, Persea gratissima.
Blimbing, Averrhoa Bilimbi.
Bullock's Heart, Anona reticulata.
Carambola, Averrhoa Carambola.
Chiku, Achras Sapota.
Durian, Durio zibethinus.
Guava, Psidium Guajava.
Jack fruit, Artocarpus integrifolia.
Jambu bol, Eugenia malaccensis. Red Malay apple.
Lemon, Citrus Medica var. Limonum.
Lime, Citrus acida.
Manggis hutan, Garcinia Hombroniana.
Mangosteen, Garcinia Mangostana.
Monkey Jack, Artocarpus rigida.
Orange, Citrus Aurantium.
Pomelo, Citrus decumana.
Rambai, Baccaurea Motleyana.
Rambutan, Nephelium lappaceum.
Soursop, Anona muricata.
Sugar-apple, Custard-apple, Anona squamosa
Water Lemon, Passiflora laurifolia.

Numbers up to 100 seedlings	10 cents each.
Numbers up to 500 and more that 100	30 cents each.

Cover Crops.

Cassia mimosoides	seed	$1/-		per	lb.
Canavalia ensiformis	,,	30	cents	per	lb.
Centrosema Plumieri, Butterfly Pea	seed	8	cents	per	lb.
Clitoria cajanifolia,	,,	50	,,	,,	,,
Crotalaria striata	,,	50	,,	,,	,,
Crotalaria usaramoesis	,,	50	,,	,,	,,
Dolichos Hosei, Sarawak Bean.	cuttings	$1.50	per		sack.
Leucaena glauca	seed	50	cents	per	lb.
Mikania scandens	cuttings	$1.50	per		sack.
Mimosa invisa, Giant mimosa	seed	50	cents	per	lb.
Mucuna sp.	,,	50	,,	,,	,,
Phaseolus lunatus, Lima Bean	,,	50	,,	,,	,,
Tephrosia candida	,,	50	,,	,,	,,
Tephrosia Hookeriana	,,	50	,,	,,	,,
Tephrosia purpurea	,,	50	,,	,,	,,

Grasses.

Australian Blue Couch, Digitaria didactyla,	$1.50 per bag of plants.
Bermuda, Cynodon Dactylon	$1.50 per bag of plants.

Carpet grass, Axonopus compressus	seed $1/- per lb.
Citronella, Andropogon Nardus	$2.50 per 1,000 plants.
Guinea grass, Panicum maximum	$2.50 ,, 1,000 ,,
Lemon, Andropogon citratus	$2.50 ,, 1,000 ,,
Love grass, Andropogon aciculatus	$1.50 per bag of plants.
Natal Red Top grass	$1.50 ,, ,, ,, ,,
Paspalum dilatatum	$1.50 ,, ,, ,, ,,

Seed, when available, 10 cents per oz.

European Vegetable Seeds.

Large seeded varieties e g., beans	20 cents per oz.
Others	40 ,, ,, ,,

Fibres.

Bimlipatam Jute, Hibiscus cannabinus	seed $1/- per lb.
Kapok, Eriodendron anfractuosum	seed 30 cents per lb.
Manila Hemp, Musa textilis	suckers 10 cents each.
Mauritius hemp, Furcraea gigantea	bulbils $1/- per 100.
Mauritius hemp, Furcraea gigantea	young plants $3 per 100.
Roselle, Hibiscus Sabdariffa var. altissima	seed $2 per lb.
Sisal Hemp, Agave rigida var. sisalana	bulbils $1 per 100.
Sisal Hemp, Agave rigida var. sisalana	young plants $3 per 100.

Miscellaneous Economic Plants.

Arrowroot	tubers 20 cents per lb.
African Oil Palm, Elaeis guineensis	seed $6 per 1,000
African Oil Palm, Elaeis guineensis	seedlings $20 per 100.
Bixa Orellana	seed $1 per lb.
Castor Oil	seed 50 cents per lb
Coffee, Robusta and Liberian	seed 50 cents per lb
Coffee, Robusta and Liberian	plants $3 per 100.
Gingelly	seed 50 cents per lb.
Ipecacuanha, Psychotria Ipecacuanha	cuttings 10 cents each.
Ipecacuanha, Psychotria Ipecacuanha	young plants 40 cts. each.
Jerusalem artichoke, Helianthus tuberosus	tubers 20 cents per lb.
Maize	seed 20 cents per lb.
Patchouli, Pogostemon Patchouly	unrooted cuttings $2 per 100.
Patchouli, Pogostemon Patchouly	rooted cuttings $15 per 100.
Sweet potato, Ipomoea Batatas	cuttings $1 per 100.
Tobacco	seed $2 per oz.
Tuba Root, Derris elliptica	unrooted cuttings $2 per 100.
Tuba Root, Derris elliptica	rooted cuttings $15 per 100.

Non-economic Plants.

Flowering trees	seedlings 50 cents each.
Flowering trees	seed 10 cents a packet.
Shade trees	seedlings 50 cents each.
Shade trees	seed 10 cents a packet.
Shrubs	rooted cuttings 30 cents each.
Shrubs	unrooted cuttings 5 cents each.

Climbers	rooted cuttings 30 cents each.
Climbers	seed 10 cents a packet.
Showy annuals	seed 10 cents a packet.
Palms	seedlings 50 cents each.
Palms	seed 10 cents a packet.
Ferns	cuttings 25 cents each.
Bulbs	10 cents each.
Standards	50 cents each.

The above prices are quoted for material when available. Planting material of other agricultural or horticultural plants will be quoted, on application, when available.

Orders for planting material should be addressed to the Agriculturist, S.S. & F.M.S., Kuala Lumpur. A remittance to cover the amount should accompany the order.

Note :—The price list includes the cost of freight.

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SCOTINOPHARA COARCTATA, F. (The Black Bug of Padi).

By G. H. Corbett and Mohammed Yusope.

Introduction.

THE principal sucking insects which attack Padi in Malaya from time to time are *Leptocorisa* spp. which reduce the yield by sucking the sap from the developing grain, *Nephotettix bipunctatus*, F. which sucks the sap from the leaves and stems and is occasionally responsible for causing considerable damage to the padi plant, and *Scotinophara coarctata*, F. In certain districts, this bug is liable to cause more damage than any other insect pest of padi, since it may entirely prevent the formation of grain by sucking the sap from the stems of the plant, and owing to the difficulty attending its control where water is unavailable, cultivators are often helpless when it increases to large numbers. The natives of Malaya consider that this insect lives naturally on grasses in the jungle, and support for this belief has been obtained in the field at Pekan in Pahang, Parit in Perak, and Kundang in Selangor, where outbreaks of *S. coarctata* occurred on padi which had been planted just after the jungle had been felled.

Dialect names in Malaya for *S. coarctata*.

Kutu bruang	... A bear-like bug.
Benah kura	... A tortoise-like pest.
Kutu ayer	... A water bug.
Kepending ayer	... A water bug. (in Sumatra).
Jebat	... An insect having the smell of a civet cat. (in Kedah).

HISTORICAL.

. The first reference to *Scotinophara coarctata* being injurious to Padi which has been traced in our available literature was in the Salem district of India in July, 1907, but it was not till October, 1918, that the damage caused by this insect was reported to the Department of Agriculture, Federated Malay States. Inche Abdul Rahman, who was Sub-Inspector of Coconuts in Pekan, Pahang, wrote to the Chief Agricultural Inspector, Mr. F. W. Smith, to the effect that this insect attacked "wet" and "dry" padi in every Pahang river Mukim of the Pekan District, and he had tried to treat it with a weak solution of Izal On the 15th. November, in reply to a Memorandum from the Chief Agricultural Inspector, he forwarded specimens of the insects and stated that they were called by the Malay "Kutu bruang bangsa amping"* Correspondence continued between the Chief Agricultural Inspector, the Acting Government Entomologist, (Mr. P. B. Richards), and the Sub-Inspector of Coconuts, Pahang. On the 10th. December, 1918, a telegram was received from the District Officer, Pekan. "Junior Agricultural Assistant reports extensive damage by 'Kutu bruang.' Sample sent last mail. Is it possible to send some one to assist taking preventive measures ?" In reply to this telegram recommendations were made for the control of the insect, and the junior author was instructed to leave Kuala Lumpur in August, 1919, for Pekan. He was stationed there for five months making preliminary observations and investigating the habits of this insect. On the 2nd. September, 1919, the then Assistant Agricultural Inspector for Negri Sembilan and Pahang, (Mr. D. H. Grist), received a report from a Malay in Kuantan that "these insects make their nests in the nursery bed and lay their eggs down there just in the stems of the seedlings, and the nests look like the nests of "Penyengat Daun" (small leaf wasp). In one of these nests there will be hatched about ten young "Kutu bruang." For the lack of knowledge about these nests by the native growers, when they remove the seedlings for transplanting, the nests are carried along with them. This pest was first found in Kampong Darat, Kubang Buaya and Alor Tok Sera. I am sending you under separate cover young padi plants destroyed by this pest and also its eggs."

ECONOMIC IMPORTANCE.

The economic importance of this insect may be gauged from a letter written by the District Officer, Pekan, dated October, 1920, to the Secretary to Resident, Pahang, who stated that "the rice pest—a sucking bug known as "Kutu bruang" or *Podops*—has this year been as rife as ever in this District. I am unable to say the extent of the damage caused by its depredations—they are still in process—but it is certain that nearly every padi field is being attacked and that many will bear nothing. During the last few years this pest seems to have grown annually worse, and I noted in my report for 1918 that whole areas were wiped out by this disgusting bug."

* A bear-like bug similar in appearance to toasted padi grain.

NATURE OF INJURY.

Adults and nymphs after the first moult suck the sap from any portion of the padi plant, but especially from the bases of the stems, and if in large numbers so weaken the vitality of the plants that seed is not produced. In severe attacks the plants are stunted, the leaves reddish brown in colour, and only occasional plants with panicles may be seen throughout the field. If this insect is in small numbers, little noticeable injury is observed. The following figures are given as an indication as to the number of nymphs and adults on padi plants considered to be suffering slightly and severely from the continuous extraction of sap. In Count No. (1), the leaves were slightly reddish in colour. In Count No. (2), the leaves were decidedly reddish-brown in colour and very few healthy leaves were seen. In each Count ten plants were taken.

	Number of plants.										Number of nymphs and adults present.	Average number on each plant.
Count.	1	2	3	4	5	6	7	8	9	10		
No. (1)	20	12	2	2	5	26	10	7	7	9	100	10
No. (2)	24	107	83	57	96	59	33	78	65	71	673	67.3

S. coarctata being capable of rapid increase, the plants in Count No. (1) may after a short time have possessed a similar number of the stages and have borne the same appearance as the plants in Count No. (2).

Owing to the difficulty of dissociating other causes—insects, soil and moisture—in reducing the yield of the padi, the loss due to the agency of the various stages of *S. coarctata* cannot be estimated, but when present only in slight numbers the vitality of the plant is weakened so that a reduction in yield, though possibly small, occurs, and in large numbers sufficient seed may not be produced to repay the expenses of harvesting.

DISTRIBUTION.

In Distant's Fauna of India, Rhynchota, Vol. 1., *Scotinophara coarctata*, is recorded under the name of *Podops coarctata*, in "Tranguebar, Ceylon, Burma, Rangoon, Bhamo, Teinzo, also a common species in the Malay Peninsula and received from Java."

In Malaya this insect has been recorded from the States of Kelantan, Pahang, Perak, Negri Sembilan and Malacca, but the extent of the damage to padi varies considerably in different localities.

Description of the Egg and Instars.

Egg. (Fig. i, a, b.).

The egg, with the exception of the operculum, is shiny pale greenish grey in colour, cylindrical in shape and finely roticulated. In colour, the top is greyish white, indicating the cap which splits to allow the nymph to emerge.

The egg measures about 1 millimetre by .6 millimetre. The measurements of 100 eggs gave the following averages :—Shorter axis .65 millimetre, longer axis 1 millimetre. The longer axis is at right angles to the surface of attachment. The egg increases very slightly in size during its development. When the egg is about two days old, the colour changes to greyish pink, on the day before hatching the whole egg is whitish pink in colour, but the cap is more pink with two distinct pink lateral spots on the margin corresponding to the eyes of the developing nymph.

Nymphal Stages.

The young bug in the course of its life moults five times, increasing in size after each moult and acquiring wings at the fifth.

First Instar. (Fig. ii.)

The young nymph on hatching from the egg has the head, thoracic segments, and markings on the mid-dorsum and connexivum brown, whilst the abdomen between the mid-dorsum and the connexivum is yellowish green with black spots. It is oval in shape, broadest across the middle of the abdomen and narrowest across the head. Newly emerged, the nymph measures about .64 millimetre in length and .51 millimetre in width, but after two days about 1.2 and .80 respectively. It is distinctly convex on the dorsal and slightly convex on the ventral surface.

The head is bent slightly downwards. The eyes, placed laterally, are red and prominent. The four-jointed antennae are yellowish brown : the basal portion of the first joint slightly pink, and the apical portion of the fourth, which is swollen, dark brown in colour. The proboscis extends about half the length of the body, reaching the second abdominal segment.

The thorax is dark brown in colour, the prothoracic segment being the longest ; the legs are hairy and yellowish brown in colour, the tarsi 2-jointed terminating in two small hook-like claws. A central demarcation, more prominent on the thoracic segments may be followed to the last adbominal segment.

In a short time, the abdomen assumes a distinct reddish brown colour which is especially noticeable between the abdominal markings.

The abdomen has nine segments, and although the divisions are difficult to follow, each segment would seem to carry a somewhat rectilinear marking. The third marking is longer and broader than the first two but shorter than the fourth and fifth, and the latter is slightly longer than the former but more rounded at the distal end. The sixth, seventh, eighth and ninth markings on their respective segments seem to coalesce in some specimens.

Second Instar. (Fig. iii.)

After the exoskeleton has hardened, the second stage nymphs wander actively and commence to feed. If they are not supplied with food soon after moulting death rapidly ensues.

The second stage nymph measures 1.75 millimetre in length and 1.00 millimetre in width. At first the general colour is distinctly pink in appearance but later a darkish brown colour is more in evidence. The whole body especially the abdomen possesses depressions.

The head is more pronounced and is light brown in colour. The apex of the fourth joint of the antenna is almost black.

The thorax is light brown at the mid-dorsum and between the margin and mid-dorsum dark shiny brown.

The abdomen is pinkish brown in colour with the exception of the markings which are dark brown and the connexivum which is light brown. The third, fourth and fifth markings are conspicuous, the first and second are difficult to make out. On each of the fourth and fifth markings there are two lateral openings indicating the pores of the repugnatory glands.

In this stage nymph, the segments of the abdomen are more prominent at the connexivum.

Third Instar. (Fig. iv.)

The third stage nymph measures 2.8 millimetres in length and 1.9 millimetre in width. The antennae are brown and the eyes are dark purplish red. The head and thorax are yellowish green pitted with red depressions. The prothorax has one, the mesothorax two and the metathorax one lateral greenish brown marking on each side.

The abdomen is light yellow with red depressions and streaks. The third, fourth and fifth markings are prominent and greenish brown in colour.

Fourth Instar. (Fig. v.)

The fourth stage nymph measures 5 millimetres in length and 3 millimetres in width.

The colour of the thorax is dark brown : the greenish areas mentioned in the third stage have changed to light brown. The mesothoracic segment shows a central and two lateral projections indicating the scutellum and the hemelytra of the adult. The abdomen is olive green in colour with red depressions and reddish markings at the divisions of the segments.

FIFTH INSTAR. (Fig. vi.)

The fifth stage nymph measures 7 millimetres in length and 3.75 millimetres in width. The colour of the thoracic segments is darker brown than that of the fourth stage nymph. The eyes are almost black in colour. On the pro-and meso-thoracic segments is a pair of yellow coloured markings.

Projections are now seen from the metathorax, and those from the mesothorax are more prominent. The third, fourth, and fifth, markings on the abdomen are conspicuous, and around these markings the colour is yellow, whilst the remainder of the abdomen is brownish red diffused with yellow ; the pits are dark brown.

SIXTH INSTAR.

The Newly Emerged Adult.

Newly emerged the adult appears white, has red oculi and pinkish coloured ocelli. Closer examination shows the scutellum and abdomen to be tinged with green and to possess numerous pink spots and markings. The antennae are five-jointed, the second and fourth being pinkish in colour, and the first, third and fifth white. Later, the adult becomes grey, then reddish brown, and finally black.

THE ADULT. (Fig. vii.)

The size varies only slightly in different specimens, the average size is 9 millimetres from the anterior margin of the head to the apex of the abdomen, and 4.5 millimetres across the broadest part, viz :— the prothorax.

The ground colour of the dorsal surface is deep brownish black to black and shiny, while the ventral surface is dull black. On this ground colour there are lighter markings of yellowish brown.

The head is black without yellowish brown markings, 1.25 millimetre in length, longer than broad. The antennae, arising from lateral projections are five-jointed ; the first joint is stout and .4 millimetre in length, the second joint is slender and .4 millimetre in length, the third and fourth joints are .55 millimetre in length, and the fifth joint is .9 millimetre in length and swollen. The two black compound eyes are very conspicuous on the lateral margins, and the two ocelli, in line with the posterior margins of the compound eyes, are dark reddish brown in colour.

The pronotum is broadest about two thirds from the anterior margin, narrower anteriorly than posteriorly with two projections on each side, one on the anterior margin and one on the broadest part. Odoriferous apertures may be seen between the second and third pairs of legs on the metasternum.

The scutellum, which almost reaches the apex of the abdomen, narrows and then broadens out at one third of its length from the base and is rounded at its apex. It has the appearance of being black with brown markings, but removed from the insect it is dark tortoise shell colour. The corium and clavus of the hemelytra are of the same colour as the scutellum.

The ventral surface of the abdomen is dull black with yellowish brown spots. The tibiae and tarsi are light yellowish brown in colour, the other joints black. The tarsi are 3-jointed.

The male is usually slightly smaller than the female, and in the male the membranes of the hemelytra extend to the tip of the abdomen, whilst in the female they stop short of the apex, exposing the abdomen which appears as a lightish band on the dorsal surface.

Deposition of the Egg.

The eggs are laid in groups varying in number from 22 to 66. Records of 113 egg masses gave an average of 38.1 eggs in each group, fifty of these masses containing from 40 to 49 eggs. The eggs are fixed at the point of their attachment and to one another by a gummy substance, and are arranged in longitudinal rows somewhat corresponding to the ridges on the leaves of the plant. The eggs in one row fit between the eggs of the next row. There are generally more eggs in the central row than in the rows on either side, giving the group a somewhat hexagonal appearance.

When padi is growing under "dry" conditions, the eggs are generally found towards the base of the plant, and are sometimes laid in the cracks of the soil and on the roots; in flooded areas, they are laid on the lower leaves or even further up the stem. In the insectary, a certain degree of moisture was found to be required for the incubation of the egg. If this was not present, the eggs turned black and did not hatch. The place of deposition might be explained by the fact that the adult deposits her eggs where sufficient moisture is present for the successful emergence of the nymph from the egg.

The eggs are mostly laid at night and rarely during the daytime.

Incubation of the Egg.

When the nymph is about to emerge from the egg, the egg splits all round the cap with the exception of a small hinge-like

portion. In the majority of cases, after the emergence of the nymph, the lid falls back to its original position leaving a circular split. The reticulation is more pronounced in the empty egg shell.

There is a very slight difference in the incubation period of the eggs in one mass and from one group to another.

Incubation Period.

Month eggs laid.	Number of eggs under observation	Number of eggs and the day they hatched after deposition.			
		Day 4.	Day 5.	Day 6.	Day 7.
1920.					
December	47	—	26	21	—
1921.					
January	38	-	—	—	38
February	112	—	72	40	--
March	226		56	170	—
April	114	—	89	25	—
May	145	—	90	55	—
June	50	—	—	25	25
July	125	56	69	—	—
August	123	20	48	55	—
September	24	—	24	—	—
1922.					
July	646	—	264	382	-
August	198	12	—	156	—
September	1782	725	889	153	15

Out of a total of 3630 eggs, 813 hatched on the fourth, 1627 on the fifth, 1082 on the sixth and 78 on the seventh day. Occasional eggs have been recorded as hatching on the eighth day, but this was probably due to the eggs having been kept under dry conditions.

Eggs Laid by Individual Females.

Observations concerning the egg-laying capacity of individual females were made on a large number of occasions. A female and male attaining adult condition on the same day were placed together in the same cage. If the male died another one was introduced. The following table gives the number of eggs laid by seventeen females.

Date nymphs attained adult condition.	Number of days elapsing before first egg-laying.	Laying periods in days.	Number of eggs laid.	Number of days between last egg-laying and death of the female.
1922.				
Aug. 23	10	106	400	76
26	21	96	478	90
27	9	112	485	50
27	11	87	528	64
28	20	95	379	38
28	18	84	485	25
29	21	92	384	43
29	22	72	394	115
29	19	94	388	7
29	11	109	443	77
29	22	87	374	7
30	16	56	303	21
31	16	89	602	42
31	17	91	416	3
31	12	104	684	58
Sept. 2	13	95	403	104
2	13	110	628	76

The preoviposition period will be seen to vary from 9 to 22 days. The maximum number of eggs laid by an individual female was 684 through an egg-laying period of 104 days. The interval between successive layings varied considerably. Some females laid groups of eggs on consecutive days, but with the majority there was always a period of non-deposition—a general average being about seven days. The number of days elapsing between the last egg-laying and the death of the female amounted to 115 in one instance.

Life Cycle.

After the hatching of the egg, the nymphs of the first instar cluster on and around the eggs from which they have hatched and seldom wander. They feed very little if at all during this period, and in later breeding work were not supplied with padi stems until after the first moult. The cotton wool at the base of the tubes was always kept slightly moist and the nymphs might have taken advantage of this moisture. The nymphs during their growth moult five times before becoming adults and after each moult the exoskeleton or skin splits dorsally along the middle of the thorax and anterior segments of the abdomen and the new nymph pulls itself slowly out and enters another instar. The time occupied in moulting is about one and a half hours.

COMPLETE LIFE CYCLE.

No.	Eggs hatched.	First moult.	First instar.	Second moult.	Second instar.	Third moult.	Third instar.	Fourth moult.	Fourth instar.	Fifth moult.	Fifth instar.	Duration of nymphal stages in days.
						1921						
1	22 June	25 June	3	3 July	8	9 July	6	14 July	5	23 July	9	31
2	22 do.	25 do.	3	30 June	5	6 do.	6	13 do.	7	23 do.	10	31
3	22 do.	25 do.	3	30 do.	5	6 do.	6	13 do.	7	21 do.	8	29
4	22 do.	25 do.	3	4 July	9	7 do.	3	13 do.	6	25 do.	12	33
5	22 do.	25 do.	3	4 do.	9	7 do.	3	13 do.	6	25 do.	12	33
6	22 do.	25 do.	3	4 do.	9	7 do.	3	12 do.	5	22 do.	10	30
7	22 do.	25 do.	3	4 do.	9	8 do.	4	14 do.	6	24 do.	10	32
8	22 do.	25 do.	3	4 do.	9	8 do.	4	14 do.	6	25 do.	11	33
9	22 do.	25 do.	3	4 do.	9	8 do.	4	15 do.	7	23 do.	8	31
10	22 do.	25 do.	3	4 do.	9	8 do.	4	15 do.	7	24 do.	9	32
11	22 do.	25 do.	3	4 do.	9	7 do.	3	13 do.	6	26 do.	13	34
12	22 do.	25 do.	3	4 do.	9	7 do.	3	12 do.	5	25 do.	13	33
13	22 do.	25 do.	3	5 do.	10	8 do.	3	14 do.	6	25 do.	11	33
14	9 July	13 July	4	20 do.	7	25 do.	5	31 do.	6	8 Aug.	8	30
15	9 do.	13 do.	4	20 do.	7	26 do.	6	2 Aug.	7	12 do.	10	34
16	9 do.	13 do.	4	20 do.	7	25 do.	5	2 do.	8	13 do.	11	35
17	9 do.	13 do.	4	20 do.	7	24 do.	4	2 do.	9	12 do.	10	34
18	10 do.	14 do.	4	22 do.	8	28 do.	6	4 do.	7	14 do.	10	35
19	24 do.	27 do.	3	4 Aug.	8	9 Aug.	5	18 do.	9	28 do.	10	35
20	24 do.	27 do.	3	4 do.	8	9 do.	5	17 do.	8	25 do.	8	32
						1922						
21	29 July	1 Aug.	3	11 Aug.	10	17 Aug.	6	23 Aug.	6	31 Aug.	8	33
22	29 do.	1 do.	3	10 do.	9	15 do.	5	21 do.	6	28 do.	7	30
23	29 do.	1 do.	3	12 do.	11	17 do.	5	22 do.	5	30 do.	8	32
24	29 do.	1 do.	3	13 do.	12	18 do.	5	22 do.	4	30 do.	8	32
25	29 do.	1 do.	3	10 do.	9	15 do.	5	20 do.	5	28 do.	8	30
26	29 do.	1 do.	3	11 do.	10	16 do.	5	22 do.	6	30 do.	8	32
27	29 do.	2 do.	4	11 do.	9	15 do.	4	21 do.	6	28 do.	7	30
28	29 do.	2 do.	4	11 do.	9	16 do.	5	21 do.	5	30 do.	9	32
29	29 do.	1 do.	3	13 do.	12	18 do.	5	24 do.	6	1 Sept.	8	34
30	5 Aug.	8 do.	3	14 do.	6	20 do.	6	27 do.	7	5 do.	9	31
31	5 do.	8 do.	3	16 do.	8	21 do.	5	28 do.	7	5 do.	8	31
32	28 do.	31 do.	3	8 Sept.	8	16 Sept.	8	22 Sept.	6	30 do.	8	33
33	28 do.	31 do.	3	8 do.	8	15 do.	7	20 do.	5	28 do.	8	31
34	28 do.	31 do.	3	7 do.	7	15 do.	8	20 do.	5	28 do.	8	31
35	28 do.	31 do.	3	7 do.	7	14 do.	7	20 do.	6	28 do.	8	31
36	28 do.	31 do.	3	8 do.	8	16 do.	8	23 do.	7	30 do.	7	33
37	28 do.	31 do.	3	7 do.	7	13 do.	6	20 do.	7	28 do.	8	31
38	28 do.	31 do.	3	9 do.	9	14 do.	5	20 do.	6	28 do.	8	31
39	28 do.	31 do.	3	9 do.	9	16 do.	7	21 do.	5	29 do.	8	32

More observations are required as to the most congenial conditions for *S. coarctata*. Nymphs emerging from the same egg mass and kept in the same cage, (their environment—temperature, food and humidity—being identical), show considerable variation in the length of time they take to become adults. In fact, soon after the first moult variation in the size of individuals is marked, and most of the later nymphal stages together with adults, which have hatched from the same egg mass, may be found together. The nymphs which remain in one instar long above the average generally die, and the same observation applies to the adults when the last nymphal stage is prolonged.

Moisture affects their development, and when nymphs are kept under dry as opposed to moist conditions the life cycle is prolonged. It would seem that in the field *coarctata* thrives best where there is stagnant water and worst where conditions are "dry," which forces the nymphs and adults to descend below the surface of the ground, usually around the roots, where a certain degree of moisture is available.

Where padi is irrigated the conditions for the breeding of *S. coarctata* are good but the adults and nymphs may be washed off the plants and distributed to other areas Heavy rains may be responsible for reducing the numbers in some areas by knocking them off the plants and burying them in the mud in which many, especially the nymphs, would succumb.

In the Table on the opposite page only nymphs have been taken which were apparently living under healthy and suitable conditions, and have therefore completed their life cycle in the shortest time. Under adverse conditions the length of time of the nymphal stages showed considerable variation, the maximum length of the life cycle being 59 days.

The average number of days from the hatching of the egg to the first moult was 8.17, from the first to the second moult 8.13, from the second to the third moult 5.12, from the third to the fourth moult 6.23, and from the fourth to the fifth moult 9.07, giving a total of 32.02 days from the hatching of the egg to the appearance of the adult.

Longevity of *S. coarctata*.

The observations on the longevity of the male and female *S. coarctata* were made when the records on the number of eggs laid by individuals were obtained.

Longevity of Female.			Longevity of Male.		
Date nymph attained adult condition.	Date female died.	Number of days.	Date nymph attained adult condition.	Date male died.	Number of days.
1922.	1923.		1922.	1923.	
Aug. 23	Mar. 3	192	Aug. 26	Mar. 2	188
„ 26	„ 21	207	„ 27	Feb. 19	176
„ 27	Feb. 14	171	„ 28	Mar. 31	215
„ 27	„ 5	162	„ 29	Apr. 3	217
„ 29	„ 1	156	„ 29	Mar. 22	205
„ 29	Mar. 26	209	„ 29	Feb. 24	179
„ 29	„ 14	197	„ 30	„ 1	155
„ 31	Feb. 21	174	„ 31	Jan. 17	139
Sept. 2	Apr. 2	212	„ 31	Feb. 11	164
„ 2	Mar. 20	199	Sept. 2	Mar. 3	182

The records above show that the maximum length of time for the life of the female is 212 and of the male 217 days. It should be mentioned that the above are examples of ten of the longest lived females and ten of the longest lived males.

Natural Enemies.

The adults and nymphs seem free from the attacks of natural enemies, probably on account of the odour emitted from the "stink" glands but the eggs, although the adults exercise a maternal care over them until after hatching, are only partially protected from the activities of an egg parasite and those outside the protection afforded by the body of the female will frequently be seen to be more parasitised than those directly under the cover of the parent. (Fig. I.C.D.).

A Chalcidoid parasite (unidentified) inserts her ovipositor into the eggs of *coarctata* and deposits an egg generally through the upper surface. The grub hatching out feeds inside on the contents of the bug's eggs and completes its development within the egg, finally emerging as an adult. This parasite, together with adverse climatic conditions, undoubtedly serves as a check of considerable importance in the natural control of this insect and if it were not for such agencies, this insect would probably be the most important pest of Padi in Malaya

Parasitised eggs are easily distinguished, as their colour turns black during the development of the parasite. The cap of the parasitised egg does not split as is the case with an unparasitised egg when the young nymph emerges, but instead a hole in the shell of the parasitised egg is seen through which the parasite has escaped.

By the above two characteristics, the colour due to the development and the emergence hole of the parasite, eggs reveal the presence of this parasite in the field and should not be crushed but treated in the manner described under control.

From parasitised eggs collected in the field only one parasite from each egg has been obtained. In the laboratory when a parasite lays more than one egg in an egg of *coarctata*, there does not seem sufficient nutriment for the development of two or more grubs and, although the egg turns black in colour, on no occasion have parasites emerged. Many observations have been made concerning the length of life of the parasite and it has been found that parasites without food of any kind may live as long as 6 days, the majority existing for 4 days. If sugar is supplied, the length of life is prolonged, the parasites having been observed to live for as long as 18 days, so that in the field, where food is available, it would appear that this parasite may live considerably longer than that indicated when no food is supplied.

LIFE CYCLE OF THE EGG PARASITE.

In the following records, the eggs of *coarctata* were laid in the laboratory and there was no opportunity of accidental parasitisation. Parasites were introduced on the same day of their emergence to eggs of *coarctata* laid on the same day. The parasites usually remained on the eggs for two hours when the egg mass was removed.

Date Parasites introduced and *S. coarctata* eggs laid.	Date parasites emerged.	Number of days.
Oct. 24	Nov. 1	8
,, 25	,, 4	10
,, 25	,, 3	9
,, 26	,, 4	9
,, 26	,, 3	8
,, 26	,, 5	10
,, 27	,, 4	8
,, 27	,, 5	9
Jan. 16	Jan. 25	9
,, 19	,, 28	9
,, 24	Feb. 2	9
,, 24	,, 3	10
Feb. 11	,, 20	9
,, 11	,, 19	8
,, 12	,, 19	7

From the above figures it will be seen that the parasite takes from 7 to 10 days to complete its life cycle, the majority taking 9 days.

Eggs of *coarctata* collected from the field showed that the parasites take from 3—4 days longer to emerge than the nymphs, and if reference is made to the incubation period which takes from 4—7 days, it will be seen that the figures generally support each other.

Interesting observations were made concerning the most suitable age of the eggs of *S. coarctata* for the parasite to deposit her egg and it was found that the parasite placed on eggs of *coarctata* four or five days' old does not prevent the emergence of nymphs, but on eggs of one, two and three days' old, the grubs of the parasite are effective in destroying the contents of *coarctata* eggs.

Value of the Parasites.

The eggs of *coarctata* were first observed to be parasitised in September, 1919, at Pekan, Pahang. Subsequently, eggs indiscriminately collected from Pekan and at different places in the neighbourhood were examined in order to find out the degree of parasitisation.

Egg Masses collected in Pahang.

Number of eggs in a group.	Number of parasites from each mass.	Number of eggs in a group.	Number of parasites from each mass.
53	20	44	37
43	21	61	37
46	15	44	31
37	16	38	3
47	12	39	39
53	20	42	22
50	29	41	31
56	48	61	13
44	0	41	39
66	66	42	24
39	35	63	37
37	37	68	25
49	40	45	16
49	18	54	30
46	0	40	23

The number of eggs represented in the groups is 1433 and the parasites emerging from them numbered 787, giving a percentage parasitisation of 54.9. Attention might be drawn to the fact that two egg masses contained no parasites and three groups were completely parasitised.

From ten egg masses containing 376 eggs collected at random at Tanjong Batu in November, 1919, 142 parasites were obtained, giving a percentage of 37.7. From seven egg masses containing 308 eggs collected at Langgar in December, 1919, 150 parasites were

obtained, giving a percentage of 48.7. Out of 30 egg masses containing 1045 eggs collected at Kampong Kemahang on 26th. November, 1919, 762 eggs were parasitised, giving a percentage parasitisation of 72.9. Out of 12 egg masses containing 406 eggs collected at Kampong Sungai Matdulang, 263 eggs were parasitised, giving 64.7 as the percentage.

The above five collections of eggs at different places give an average parasitisation of 55.7 per cent. Since these records were made this parasite has been found generally distributed throughout Malaya, undoubtedly exercising a controlling influence. It is considered that the collection of egg masses and treating them in a manner to be described later would be of considerable assistance in controlling this insect.

Preventive and Remedial Measures.

The control for *S. coarctata*, unless water can be regulated, must consist almost entirely of preventive measures. In areas where *coarctata* is known to be a pest, no attempt is made to prevent the succeeding padi crop suffering from the ravages of this insect. After harvest, self-sown padi, grasses and weeds are allowed to grow until the next crop is about to be sown. Cultivators seem quite content to obtain sufficient padi to provide for their own requirements and generally demand assistance when a particular insect is working havoc with their crops, which might have been largely prevented if clean culture had been practised.

S. coarctata has been found in the jungle feeding on "Rumput Kumpai" (*Panicum myurus*), "Rumput Sendayan" (*Scleria sumatrensis*), "Mendeiong" (*Scripus grossus*), and other unnamed grasses or sedges; in swampy places on grass; on both "dry" and "wet" padi in the nursery and in the field; on every part of the padi plant, including root and leaf; in cracks in the soil; under the heaps of partially decayed padi and grasses prior to and after transplanting padi, under lumps of earth after the land has been ploughed for the next padi crop, and between padi seasons feeding on volunteer padi, padi stubble and grasses.

From the habits of *S. coarctata*, the importance of keeping the padi area and banks as clean as possible during the "dead" season cannot be too strongly emphasised. After the crop has been harvested all stubble should be burned and the area kept clean of all plants liable to support this insect until the next seed is sown.

Collecting.

The first consideration in the control of this insect is the destruction of all breeding places and keeping the land as clean as possible after harvesting the padi crop, the second to collect eggs, nymphs and adults from the nursery beds, to see that every seedling taken from the nursery to the field for transplanting is free from the various stages, and to pay due attention to padi after it has been planted out. The presence of *coarctata* is often revealed by the padi

showing unhealthy patches. All these areas should be very carefully inspected and if eggs and bugs are found they should be collected. Nymphs and adults are frequently found in the morning high up the plants, and when in such positions, hand nets have been used with success. The nymphs and adults collected should be placed in a receptacle containing a small quantity of kerosene oil.

The eggs are frequently parasitised, and to encourage further parasitisation they should not be crushed but placed in a box without open joints and provided with a lid. Into one side of the box a small glass tube should be inserted. The idea being that parasites emerging from the eggs and being attracted to light will be seen in the tube. The tube should be removed every day, the parasites allowed to escape and the bugs hatching from the eggs destroyed. Destroying the nymphs and adults, and treating the eggs in the manner described are most important, especially in the case where "dry" padi is cultivated or water is not sufficiently controlled. Where irrigation is practised or water can be controlled, the attacked area should be flooded. After a short time, nymphs and adults rising to the surface of the water may be collected by skimming them off the surface and dropping them into tins containing kerosene.

Light Traps.

Light traps, consisting of a round tin, about 8" in depth and 24" in diameter, containing a small quantity of water with a film of kerosene oil, in the centre of which a "Storm King" lamp is placed, have been employed on various occasions, but although *coarctata* is occasionally attracted to light, success has not been obtained in the field to such an extent that light traps can be recommended.

Insecticides.

Experiments were conducted with kerosene emulsion and "Tuba" root, (*Derris* sp.). The results obtained indicated that both these sprays have a marked killing effect on the various stages of *S. coarctata* but since the quantity required would make the operation of spraying too costly, unless *Derris* plants were grown by the cultivators, this method of combating the insect is not recommended.

Description of Plate.

Fig. I.A. Eggs of *S. coarctata*, about twice natural size.
B. Eggs of *S. coarctata*, side view, about twice natural size.
C.D. Egg mass showing parasitised eggs on the margin of the group.
Fig. II. First stage nymph (greatly enlarged).
III. Second stage nymph („ „).
IV. Third stage nymph („ „).
V. Fourth stage nymph („ „).
VI. Fifth stage nymph („ „).
Fig. VII. *Scotinophara coarctata*, F. („ „).

The lines at the sides of the Figures indicate approximately the size of the insect at the various stages.

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Fig. I

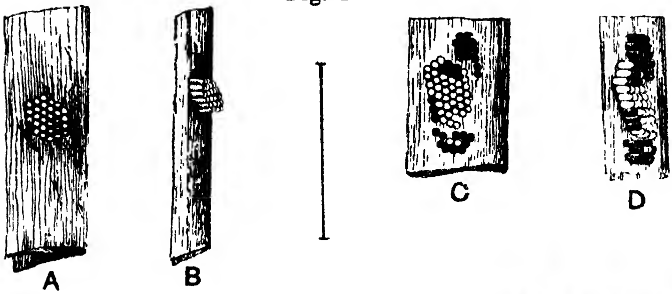


Fig II

Fig III

Fig. IV

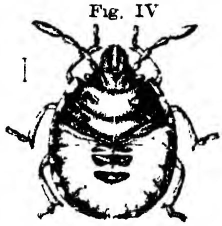


Fig V

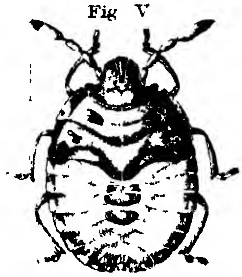


Fig VI

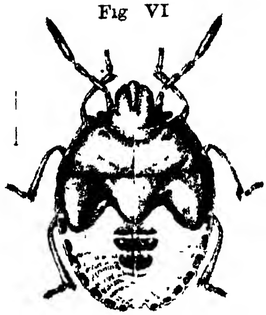
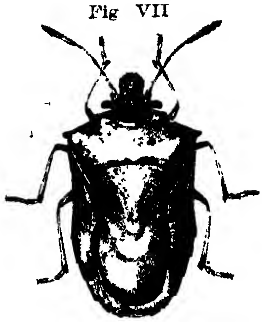


Fig VII



Scotinophara coarctata, F.

AN INVESTIGATION ON THE TOXICITY OF THE LIMA BEAN.

(*Phaseolus Lunatus.*)

By V. R. Greenstreet.

OWING to a prevalent idea that the Lima bean possesses toxic properties due to the presence of a cyanogenetic glucoside[1], this nutritive article of diet[2] has fallen into disfavour both in Europe and the East.

Nutritive value.

The following figures (table I) published by Bonâme[3] show the composition of the bean.

TABLE I.

Percentage composition of the Lima bean.

Water	Ash	Cellulose	Fat	Carbohodrate	Protein
11.70	3.70ˣ	6 25	0.94	53.29	24.12

ˣcontaining

Phosphoric acid 24.36 per cent. Nutrient Ratio = 1 : 2.4

Potash 49.36 per cent.

Since several workers have proved that the seeds of many members of the leguminosae contain poisonous principles to a dangerous extent[4] an investigation of the toxicity of the locally grown Lima bean was undertaken at the request of the Director of Food Production with a view to encouraging its cultivation provided the results were satisfactory.

Origin.

The beans which were used in the investigation were supplied from Kuala Kangsar Government Plantation by Mr. Mathieu, who reports as follows on their origin :--

"The Lima beans which I first planted from the consign-
"ment received from Dreer of Philadelphia had a pronounced

1. Cyanogenetic glucoside: a complex compound which on hydrolysis (decomposition) by enzymes or possibly by the acidity of the stomach yields hydrocyanic (prussic) acid.
2. Review of Agricultural Operations in India, 1921-1922. A. H. Church. Food Grains of India, 1886.
3. P. de Sornay. Green manures and manuring in the tropics. 1916.
4. M. P. Geurin. Revue Scientifique, 1907. F. J. Warth. Memoirs Department of Agriculture of India. 1923.7.1.

"purple streak in them, so much so that in my second
"attempt I made separate beds for the seeds which were
"markedly coloured. The result at harvest was to my
"surprise a pronounced loss of colour: many of the beans
"collected had turned almost white or the colouring was
"only indicated by faint lines radiating from the hilum to
"the outer edge of the beans. In further planting, these
"lines grew fainter and fainter and in five or six generations
"the beans had become white."

The fact that the sample of white beans examined was removed by only five or six generations from the coloured ones is particularly interesting in showing the effect of cultivation, since the latter have been found to be markedly toxic[5].

Experimental.

A few ounces of the beans were ground up and made into a paste with water. The paste was divided into three fractions and each placed in a tightly corked flask as follows:—(*a*) Paste only. (*b*) Paste plus mercuric chloride. (*c*) Paste plus salicylic acid. After a few hours there was a distinct odour of hydrocyanic acid in flasks (*a*) and (*c*) while (*b*) gave no odour. This proves that the hydrocyanic acid does not exist in the beans as such, but was produced from the cyanogenetic glucoside by enzyme action. The hydrocyanic acid was subsequently estimated by Henry and Auld's method[6]. Five determinations were carried out as follows:—

1. Ground beans extracted with boiling alcohol for 4 hours.

2. Ground beans extracted with boiling alcohol for 24 hours.

3. Whole beans soaked in water for 24 hours, crushed and extracted with boiling alcohol for 24 hours.

4. Whole beans boiled until soft (2 hours), crushed and extracted with boiling alcohol for 24 hours.

5. Whole beans soaked in water for 24 hours, boiled until soft (30 minutes) and extracted with boiling alcohol for 24 hours.

The following table (II) gives the results of the determination of the hydrocyanic acid content.

Table II.

Hydrocyanic acid content of the Lima bean.

Experiment number	1	2	3	4	5
Hydrocyanic acid per cent -	0.0013	0.0017	0.0020	0.0020	0.0014

5. Society of Chemical Industry Journal. 1908. 27. 428.

6. Ibid.

The amounts of hydrocyanic acid extracted in 4 hours and 24 hours (numbers 1 and 2) when plotted in a curve show that a period of 24 hours is sufficient for complete extraction.

The figures show that the Lima bean contains approximately 0.02 per cent of cyanogenetic glucoside (phaseolunatin) which upon hydrolysis yields 0.002 per cent of hydrocyanic acid. Soaking in water followed by boiling—as is usual in cooking—dissipates some of the hydrocyanic acid but either operation alone causes no reduction. Estimations numbers 1 and 2 were carried out on a different sample from numbers 3, 4 and 5 which accounts for the slight discrepancy between number 2 and numbers 3 and 4.

The lethal dose of hydrocyanic acid is stated by Witthaus[7] to be 0.05 gramme and this amount is contained in approximately 5 lbs of raw beans or 7 lbs of cooked beans. The amount of hydrocyanic acid contained in the small quantity (say 2 ounces) of beans consumed at one meal is therefore negligible and from personal experience the writer has confirmed the fact that the Lima bean is innocuous.

7. Witthaus. Manual of Toxicology, 1911.

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FRUIT.

PLANTING MATERIAL OF

THE Superintendent, Government Plantation, Kuala Kangsar, Perak, is at present in a position to supply marcots of Orange (*Citrus Aurantium*), Mango (*Mangifera indica*), and Pomegranate (*Punica granatum*), cuttings of Granadilla (*Passiflora quadrangularis*), and seedlings of the pink and the white fleshed Guava (*Psidium guajava*). Application for same should be addressed to the Superintendent.

The orange is of the Mandarine type, a small green sweet fruit. The trees at Kuala Kangsar are very prolific yielders and are recommended as a good source of planting material. It is worthy of note that the orange fruits find a very ready market in Kuala Kangsar.

Marcots of two kinds of the Indian Mango are available, one variety having large fruits and the other small. The former is the superior fruit.

F. G. S. (11-3-24.)

NOTES ON THE EXPERIMENTAL PLANTATION, SERDANG FOR THE MONTH OF MARCH, 1924.

Mr. J. N. Milsum, Assistant Agriculturist, returned from leave and assumed duty on the 29th March, 1924.

The only new planting material received during the month was a small sample of seed of Bulrush Millet (*Pennisetum typhoideum*) from the Superintendent, Government Plantation, Kuala Kangsar.

Half-acre plots of ten varieties of Groundnuts (*Arachis hypogaea*) were planted up and a comparison will be made of the yield of the different varieties when the crop is harvested.

An area of 2 acres reserved for experiments in connection with a rotation for Roselle fibre (*Hibiscus Sabdariffa* var. *altissima*) was replanted with green crops preparatory to commencing the proposed rotation which is as follows:--(1) Groundnuts (2) Roselle, (3) Cow Pea and (4) Gingelly.

Advantage was taken of the wet weather for supplying the planted areas.

An experimental sugar-cane mill was installed on the plantation during the period under review and it is expected to commence work on crushing cane next month. The mill in question has a capacity of about 5 to 6 tons of cane per day and is driven by a small 7, 9 H.P. portable petrol engine

Rain fell on 26 days during the month, giving a total rainfall of 9.36 inches. The heaviest rainfall in 24 hours was 2.14 inches.

The maximum shade temperature recorded was 97° F and the minimum 68° F. The average maximum shade temperature was 91.68° F and the average minimum 70.91° F.

Records of the cup-indicating anemometer show that the total run of wind for the month was 1516.89 miles, the average run for 12 hours from 6 a.m. to 6 p.m. 11.38 miles and that from 6 p.m. to 6 a.m. 8.52 miles.

B.B.—(12 4-24)

LONDON MARKET PRICE LIST, 1st QUARTER 1924.

Oil Seeds.

Castor (Bombay)	-	£23.10 per ton.
Copra (Ceylon)	-	£32 " "
Do. (Straits)	-	£30 " "
Cotton (Egyptian)	-	£13.17.6 " "
Do. (Bombay)	-	£11 " "
Croton	-	27/6--32/6 per cwt.
Desiccated Coconut (fine)	-	44/- per cwt.
Do. do. (medium)	-	43/- " "
Do. do. (coarse)	-	47/- " "
Gingelly (Chinese)	-	£26.10—£27 per ton.
Do. (Bombay)	-	£27 " "
Groundnuts (Gambia, undecorticated)	-	£18.10 " "
Do. (Chinese, decorticated)	-	£23—£23.7.6 " "
Linseed (Bombay)	-	£23.7.6 " "
Do. (Plate, new Crop)	-	£18.2.6—£18.8.9 per ton.
Palm Kernels (West Africa)	-	£20.10 " "

Oils.

Castor (Madras)	-	56/- per cwt.
Do. (pharmaceutical)	-	65/- " "
Do. (1st pressing)	-	60/- " "
Do. (2nd do.)	-	59/- " "
Coconut (Cochin)	-	55/- " "
Do. (Ceylon)	--	49/- " "
Cotton seed (Egyptian, crude)	-	45/- " "
Do. (Bombay)	-	43/6 " "
Groundnut (Oriental, crude)	-	52/- " "
Do. (English)	-	53/- " "
Linseed (Calcutta)	-	48/- " "
Do. (Plate)	-	47/- " "
Palm (Lagos)	-	£40.10 per ton.
Do. (Sumatra)	-	£39 " "
Palm kernel	-	42/6 per cwt.

Oil Cakes.

Coconut	-	£10 per ton.
Cotton	-	£7.10—£7.12.6 per ton.
Groundnut (undecorticated)	-	£9.10 per ton.
Linseed	-	£13 " "
Palm kernel	-	£6.10 " "

Essential Oils.

Cajeput	-	3/3 per lb.
Camphor (Chinese, crude)	-	3/6 " "
Do. (Japanese, refined)	-	3/6—3/9 per lb.
Do. (Oil)	-	70/- per cwt.

Essential Oils—*Contd.*

Cinnamon (Ceylon, leaf)	- 5¾d. per oz.
Citronella (Ceylon)	- 3/6—3/7 per lb.
Do. (Java)	- 4/8 ,, ,,
Clove	- 8/6—8/9 ,, ,,
Lemon grass (Cochin)	- 2¾d. per oz.
Lime (West Indian, expressed)	- 7/6 per lb.
Do. (do. distilled)	- 4/6 ,, ,,
Patchouli (Singapore)	- 21/6 ,, ,,
Vetiver (Bourbon)	- 31/- —32/- per lb.

Spices.

Capsicums (East Indian)	- 40/-—45/- per cwt.
Do. (Nyassaland)	- 60/-—65/- ,, ,,
Chillies (Zanzibar)	- 40/-—45/- ,, ,,
Do. (Nyassaland)	- 50/-—55/- ,, ,,
Do. (Japan)	- 125/- ,, ,,
Cinnamon (Ceylon)	- 8½d.—11½d. per lb.
Cloves (Zanzibar)	- 1/3—1/5 ,, ,,
Do. (Penang)	- 2/6—3/- ,, ,,
Ginger (Japanese, Cochin)	- 80/-—90/- per cwt.
Do. (Jamaica)	- 145/-—185/- ,, ,,
Mace (Bombay and Penang)	- 2/-—2/10 per lb.
Nutmegs (Singapore and Penang)—	
110's	- 1/6 ,, ,,
80's	- 1/8½ ,, ,,
64's—57's	- 1/8—2/- ,, ,,
Pepper (Singapore, black)	- 1d. ,, ,,
Do. (do. white)	- 6d. ,, ,,
Turmeric (Bengal)	- 70/- per cwt.

Drugs.

Areca	- 15/- per cwt.
Cinchona Bark	- According to Analysis.
Cocaine (hydrochloride)	- 17/6—18/- per oz.
Ipecacuanha (Matto Grosso)	- 10/- per lb.

Natural Dyestuffs & Extracts.

Annatto (seed)	- 1/2—1/3 per lb.
Gambier (black)	- 65/- per cwt.
Do. (cubes)	- 75/-—80/- per cwt.

Gums & Resins.

Damar (Singapore)	- 30/-—150/- per cwt.
Do. (Batavia)	- 120/-—160/- ,, ,,
Dragon's blood (reeds)	- £18—£20 ,, ,,
Do. (lump)	- £11—£28 ,, ,,

Fibres.

Cotton (American F.L.M. to F.G.M.)	- 18.66d.—20.71d. per lb.
Do. (Egyptian Sakellaridis, G.F. to fine)	- 23.05d.—25.65d. ,, ,,

Fibres—*Contd.*

Hemp (sisal)	- £25.10—£40 per ton.
Do. (Manila, J. Grade)	- £34.10 " "
Do. (New Zealand)	- £33--£35 " "
Kapok (Java)	- 1/4 per lb.
Do (Indian)	- 1/1 " "

Foodstuffs.

Cocoa (Ceylon, plantation)	- 60/-—100/- per cwt.
Coffee (Malay, plantation)	- 90/-—120/- " "
Do. (Malay, Liberian)	- 60/-—70/- " "
Sago (pearl)	- 28/-—30/- " "
Do. (flour)	- 17/6—18/6 " "
Sugar (white, Java)	- 52/- " "
Tapioca (Penang, flake)	- 3½d.—3¾d. per lb.
Do. (do. flour)	- 18/-—22/- per cwt.

Miscellaneous.

Guttaporcha (genuine)	- 2/9—6/- per lb.
Do. (Sarawak)	- 3/-—4/- " "
Do. (Siak, reboiled)	- 9½d. " "
Jelutong	- £30—£60 per ton.

Chemicals.

Acetic acid (glacial)	- £73—£74 per ton.
Do. (80% comml.)	- £50—£52 " "
Acetone (pure)	- £120—£125 " "
Ammonia (.880)	- £32—£34 " "
Calcium acetate (grey)	- £22—£23 " "
Citric acid	- 1/5—1/6 " "
Creosote	- 9¼d. per gallon.*
Formalin (40% vol.)	- £63—£64 per ton.
Lime Juice (raw)	- 1/9—2/6 per gallon.
Do. (conc.)	- £21 per basis.†
Sodium bisulphite (60-62%)	- £20—£22 per ton.
Sodium sulphite (anhydrous)	- £26.10—£27.10 per ton.

* Basis = 108 gallons, 64 ozs. Citric acid per gallon.

† Given erroneously in January number as per. lb.

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BATRACHEDRA ARENOSELLA, WALK., (COSMOPTERYGIDAE) IN RELATION TO THE NUT-FALL OF COCONTUS.

By G. H. Corbett and B. A. R. Gater.

Batrachedra arenosella was first described by Walker (1) from New Zealand under the name of *Gracilaria arenosella*. It is a very widely distributed species, having been subsequently recorded in Australia, Tasmania and British Guiana, and was referred to the genus *Batrachedra* by Meyrick (2), who also described it under the name of *B. psilopa*. Bainbridge Fletcher (3) records it from various localities in India.

It was first noticed in Malaya on the Bernam River, Perak (4), in the early part of 1922, and since then has been found in the majority of States in the Peninsula. Owing to the fact that the sole food plant in Malaya appears at present to be the coconut palm, it was considered that the insect might be of first-class economic importance. As far as can be seen from the available literature, *B. arenosella* has not previously been recorded on coconuts, the only reference to a food plant being from Queensland, on the seeds of *Juncus* (5). *B. amydraula*, Meyr., is recorded on the date palm in Iraq (6).

Damage Caused by the Insect.

The insect was first observed in the pupal stage on a newly opened spike. The female flowers of the spike in question showed signs of damage which was attributed to the caterpillars of *Tirathaba*, sp. near *trichogramma*, Meyr. (Pyralidae). No signs of the caterpillars of the latter could, however, be found, but on a closer examination of the spike the small white cocoons of *B. arenosella* were found at the base of the inflorescence. Several unopened spikes were then examined, which revealed the presence of numerous caterpillars and cocoons, and in some cases the newly emerged moths.

Both the male and female flowers of the inflorescence are gnawed by the caterpillars, which are frequently found feeding inside

the male flowers. The male flowers are seemingly attacked more often than the female, but in either case a brown discolouration of the tissues starts at the point of attack and sometimes travels downwards along the stem of the inflorescence. Especially is this noticeable when the male flowers have suffered considerably. It is probable, however, that the destruction of male flowers has little influence on nut-fall, since an enormous amount of pollen is always available from unattacked flowers.

The female flowers are usually attacked near the point of attachment or on the "scales" which completely envelop the young flowers until just before the stigma becomes receptive. The damage is confined to the period before the opening of the spike, and if one is cut open a few hours before it bursts it will be found that the insect is in the final stages of its life history, only very few caterpillars being found. On the unopened spikes the presence of the caterpillars can be traced owing to numerous small gum-like beads which are mostly distributed over the apical portion of the spathe

It has been found that an average of 65% of the female flowers is attacked in areas where the insect is prevalent.

Life History.

Considerable difficulty was experienced in working out the life history, especially in getting the moths to lay in captivity and in breeding the young caterpillars. Newly emerged adults were placed together on an unopened spike and confined in a small inverted funnel. They were moved to a different part of the spike or to a fresh one every day, and the surface examined for the presence of eggs.

At first the portion of the spathe carrying the eggs was allowed to remain until after the caterpillars had penetrated into the spike, but this method was abandoned owing to the difficulty of finding the minute caterpillars. Finally the portion carrying the eggs was cut out and kept in a moist chamber until the caterpillars hatched, when they were supplied with male flowers in small individual cages.

The moths usually copulated the day after emergence, but in some cases there was an interval of seven days between copulation and egg-laying. The proportionately long period between emergence and oviposition is noteworthy in relation to the opening of the spike, since many spikes on being opened are found to contain the moths as well as pupae. In the field the period from the first signs of attack to the opening of the spike is about three weeks.

A curious point was observed in connection with the copulation of the moths. In several cases the male died directly after copulation, on the same day, but remained attached to the female for one and two days after death. The females died two days after oviposition was complete and appeared to lay only one batch of eggs.

The life history has by no means been thoroughly worked out, but the available figures indicate that the cycle is short.

SUMMARY OF LIFE CYCLE.

Incubation	...	2—3 days
Larval period	...	5—8 days
Pupal „	...	6 —8 days

Total : —

Average	16	„
Maximum	19	„
Minimum	15	„

The eggs are laid in the longitudinal grooves of the spathe, never having been observed on the ridges. The caterpillars, on hatching, at once bore through the spathe, causing the gummy beads to form on the outside. Internally the points at which the larvae have eaten their way through are marked by brown discolouration extending for about a sixteenth of an inch round the minute hole. The larvae then confine their attention to the basal flowers of the inflorescence. When full grown they pupate in small oval-shaped cocoons at the base of the spike.

CONTROL

In view of the possible importance of this insect to the coconut industry, control experiments were instituted in Perak and later in Selangor.

The injection of carbon disulphide into the unopened spikes was tried, but quickly abandoned owing to the damage done to the flowers and to the impracticability of the method.

Efforts were them made to find a suitable substance with which the unopened spikes could be sprayed, or, in the case of dwarf palms, painted by hand. Spikes would have to be treated several times in the course of their growth, and such a method would only be practicable if the saving of nuts were commensurate with the labour expended.

A block of palms grown under ordinary estate conditions and suffering from a large amount of nut-fall was selected for experiment. Spike moths were prevalent on the area, and presumably were responsible for the yield being rather below the average. The plot consisted of 132 palms of eight to nine years of age which were cleaned up so as to be easily accessible by means of a ladder. The experiments on some trees had to be abandoned owing to the production of spikes with few female flowers, and in some cases work had to be

temporarily stopped owing to the presence of red ants (*Oecophylla smaragdina*, F.) and nettle caterpillars (*Setora nitens*, Walk.) The extent of the experiment was limited owing to the impossibility of examining a larger number of palms at regular intervals, and the very few insecticidal substances available.

Ten rows of palms were treated with separate substances by painting or spraying the spikes weekly from their appearance to opening. Two rows were used as controls. On opening, the number of attacked and unattacked female flowers was counted, and records taken of the fall of each. Distinctively coloured paint was applied to the flowers at the first examination to simplify the records of the fall of attacked and unattacked immature nuts. Records were obtained of [illegible] female flowers on [illegible] spikes for control purposes, and of [illegible] female flowers for a period of twelve weeks. The latter were used in order to ascertain the ultimate yield from attacked and unattacked flowers, since it was considered that after the twelfth week any injury due to the insect would be negligible.

The details of the control experiments are given in table I, showing the reduction of injured female flowers following the use of each substance compared with the number of flowers naturally attacked in the same area. All the substances were painted, with the exception of lead arsenate which was painted and sprayed. In the latter case very little beneficial effect was obtained, owing to the the lead arsenate not spreading efficiently over the spike.

In many respects the comparative value of the substances used is more a measure of their capability of spreading evenly over the peculiar surface of the coconut spike than of their actual insecticidal powers. Lead arsenate, used in four different media, shows varying beneficial effects which are attributed to the adhesive and spreading powers of the medium. Standard formulae were used in making up the insecticides.

TABLE I.—*Control.*

	Treatment.	No. of spikes	Total ♀ flowers	No. injured	% injured
	Control.	46	487	275	56
1	Tar oil (miscible) I	23	371	37	10
2	Lead arsenate + sugar	45	538	170	32
3	Rosin wash + Lead arsenate	27	323	103	32
4	Tobacco + soap	33	604	202	33
5	Lead arsenate — painted	37	343	123	36
6	Tar oil (miscible) II	36	434	160	37
7	Rosin wash	27	372	140	38
8	Kerosene emulsion	32	444	174	39
9	Bordeaux mixture	20	219	98	45
10	Lead arsenate — sprayed	32	323	176	54

TABLE II.—*Daily and weekly nut-falls expressed as percentages of the total female flowers present at opening of spikes.*

—	Day No.	Per cent. I.	Per cent. U.	Day No.	Per cent. I.	Per cent. U.	Day No.	Per cent. I.	Per cent. U.	Day No.	Per cent. I.	Per cent. U.	Day No.	Per cent. I.	Per cent. U.	Day No.	Per cent. I.	Per cent. U.
	1	—	—	15	1.432	.109	29	2.435	3 078	43	4.726	3 732	57	.429	.439	71	—	—
	2	—	—	16	.143	1.756	30	3.151	5.378	44	2.435	4.390	58	1.575	.878	72	—	—
	3	—	—	17	.716	1.317	31	4 154	3.732	45	1.575	.439	59	—	.548	73	.286	.109
	4	.143	.329	18	1.575	.219	32	.429	.768	46	.859	.109	60	.716	.439	74	—	.219
	5	.429	.219	19	1 002	548	33	4.441	4.281	47	4.011	2.414	61	.143	.109	75	—	—
	6	.859	219	20	1.146	2 744	34	.286	1.646	48	1.116	.768	62	.143	.329	76	.286	—
	7	1.146	987	21	2 005	1.427	35	1.002	1.097	49	3.438	5.378	63	.143	.768	77	—	—
Weekly	1	2 577	1.754	3	8.019	8.120	5	15.898	19.975	7	18.190	17.230	9	3.149	3.510	11	.572	.328
	8	—	.439	22	1.289	1.975	36	4.011	6.476	50	.716	.548	64	.286	.548	78	—	—
	9	—	—	23	1.719	1.646	37	5 873	4.390	51	2.292	1.646	65	—	—	79	—	—
	10	143	.439	24	.859	.109	38	2 292	.439	52	.429	—	66	—	.109	80	—	.109
	11	.859	.878	25	5.587	3 512	39	1.575	2.414	53	.716	.548	67	.143	.109	81	—	—
	12	1.289	.329	26	3.724	2.744	40	4.011	2.854	54	.859	1.756	68	.429	.109	82	—	—
	13	—	.878	27	1 289	1.756	41	—	2.963	55	.716	.329	69	.143	.219	83	—	—
	14	.286	.219	28	2.578	1 427	42	3.008	.987	56	.286	.987	70	—	—	84	—	—
Weekly	2	2 577	3 182	4	17.045	13.169	6	20 770	20.523	8	6.014	5.814	10	1.001	1.094	12	—	.109

I.—Injured flowers. U.—Uninjured flowers.

Nut-fall from other Causes.

During the course of the control experiments it was observed that a large amount of nut-fall occurred with nuts which had not been injured by *B. arenosella* or other insects. Certain palms were therefore selected with a view to ascertaining the total nut-falls which occurred, and the actual number of falls for which the insect was responsible; and records were kept of the fall of the injured and uninjured female flowers for a period of twelve weeks, the results being expressed as percentage daily and weekly falls in table II, and the accompanying curves.

From a total of 1609 female flowers, only 76 remained at the end of the period. This colossal fall, amounting to 95%, cannot be accounted for by insect injury; in fact the curves of the fall of flowers whether injured or not run very closely together. Of the 76 nuts remaining, 47 were uninjured and 29 were injured flowers. Expressed as percentages, however, there is remarkably little difference between the fall of injured and uninjured flowers. Of the 1609 female flowers 698 were injured and 911 were uninjured, giving percentage falls of 95.84 and 94.84 respectively. It will thus be seen that at the twelfth week the apparent damage caused by the insect is only 1%.

It may be argued that other causes effecting the fall of nuts mask the real damage caused by the insect, but such causes would probably act equally on both injured and uninjured nuts. On the other hand it is reasonable to presume that other causes acting on flowers already injured by the insect, would accelerate their fall, and this is what appears to happen in the earlier part of the falling-period.

It has been mentioned that a discolouration of the stem of the inflorescence occurs after insect attack, and this is especially noticeable where the male flowers have been injured. This may have an important influence on the fall of other flowers on the same spike, although they may not necessarily have themselves been attacked. Such conditions would undoubtedly increase the figure for the fall of "uninjured" flowers. To what extent nut-fall is caused by indirect injury of this nature must form the subject of another investigation.

If curve No. I, be examined it will be seen that the daily percentage falls are approximately the same for injured and uninjured flowers, except up to the 28th. day, and again on the 37th. and 47th days.

Curve No. II, gives the weekly percentage falls, and it will be seen that there is a slight predominance of injured nut-falls in the first week and a larger one in the 4th. A sharp drop occurs at the 5th week followed by a rise at the 6th. The most noticeable portion of the curve is that for injured flowers between the 3rd and 6th weeks. After the 6th week the curves for the fall of injured and uninjured flowers correspond closely.

The rise in the injured curve at the fourth week is attributed to the acceleration of the "normal" fall, due to insect injury. The rise in the first week can be attributed to direct injury by the insect, whereas that in the fourth week may be due to an acceleration of the fall of unpollinated flowers which would not normally occur until the fifth or sixth weeks.

The total fall of flowers increases rapidly from the second to the fifth week and is maintained for another week, when it reaches its maximum. In many ways the time of fall corresponds with that on which unfertilised flowers would normally fall.

Little work appears to have been done on the pollination of coconuts, but Jack and Sands (7) have worked on dwarf coconuts in this country. They state that self pollination, *i.e.* pollination from male flowers on the same spike, is the rule for the dwarf and tall palms, and not a somewhat rare occurrence.

Aldaba (8), however, working on the pollination of the tall coconuts in the Philippines, states that normal pollination takes place from other spikes on the same or different palms. He also states that female flowers do not become receptive until two or three weeks after the appearance of the inflorescence, and remain open for two or three days, after which they turn brown towards the stigmatic end, shrivel and die. The majority of falls were found by him to have been due to non-pollination.

The writer's investigations were in no way concerned with the pollination of coconuts, but owing to the large fall which occurred after the third week, and the casual observation that the female flowers become receptive at about the time stated by Aldaba, they formed the opinion that a considerable amount of nut-fall was due to non-pollination. It would be interesting to amplify the work done by Aldaba on the artificial pollination of coconut flowers. Gadd (9) working in Ceylon concludes that the fall of female flowers is the natural result of over-production, and that external conditions such as drought may adversely affect their fall. He further states that the fall of older but still immature nuts may be caused by fungus diseases, especially *Phytophthora*, and by mechanical or physiological causes.

Any or all of these causes may have been responsible for the fall of immature nuts not due to *B. arenosella*, and without concerted action on the same area it is impossible to ascertain the exact part played by each one. In so far as the direct injury by *B. arenosella* is concerned, it has very little influence.

The authors are indebted to Mr. H. T. A. Biddlecombe, without whose generous co-operation the work could not have been carried out, and also to Mr. W. Malcolm Miller.

Summary.

1. *Batrachedra arenosella* injures the flowers of the unopened coconut spike.

2. The eggs are laid on the spathe and the larvae bore into the spike. The life history is complete in about 16 days.

3. An average of 65% of the female flowers is injured in certain districts of Malaya. A control was found which on an area having 56% of the female flowers injured reduced the injury to 10%.

4. The yield of unattacked nuts was only 1% more than the yield from attacked nuts after the 12th week.

5. The majority of the nut-falls on the area was attributed to other causes.

6. The direct injury caused by *B arenosella* is negligible.

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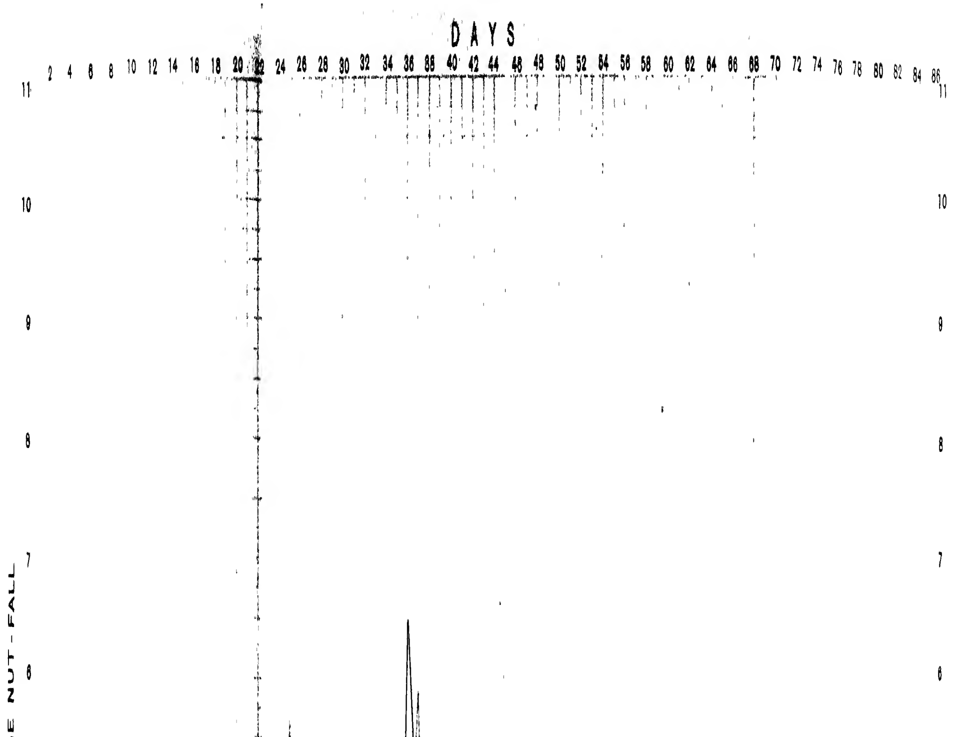
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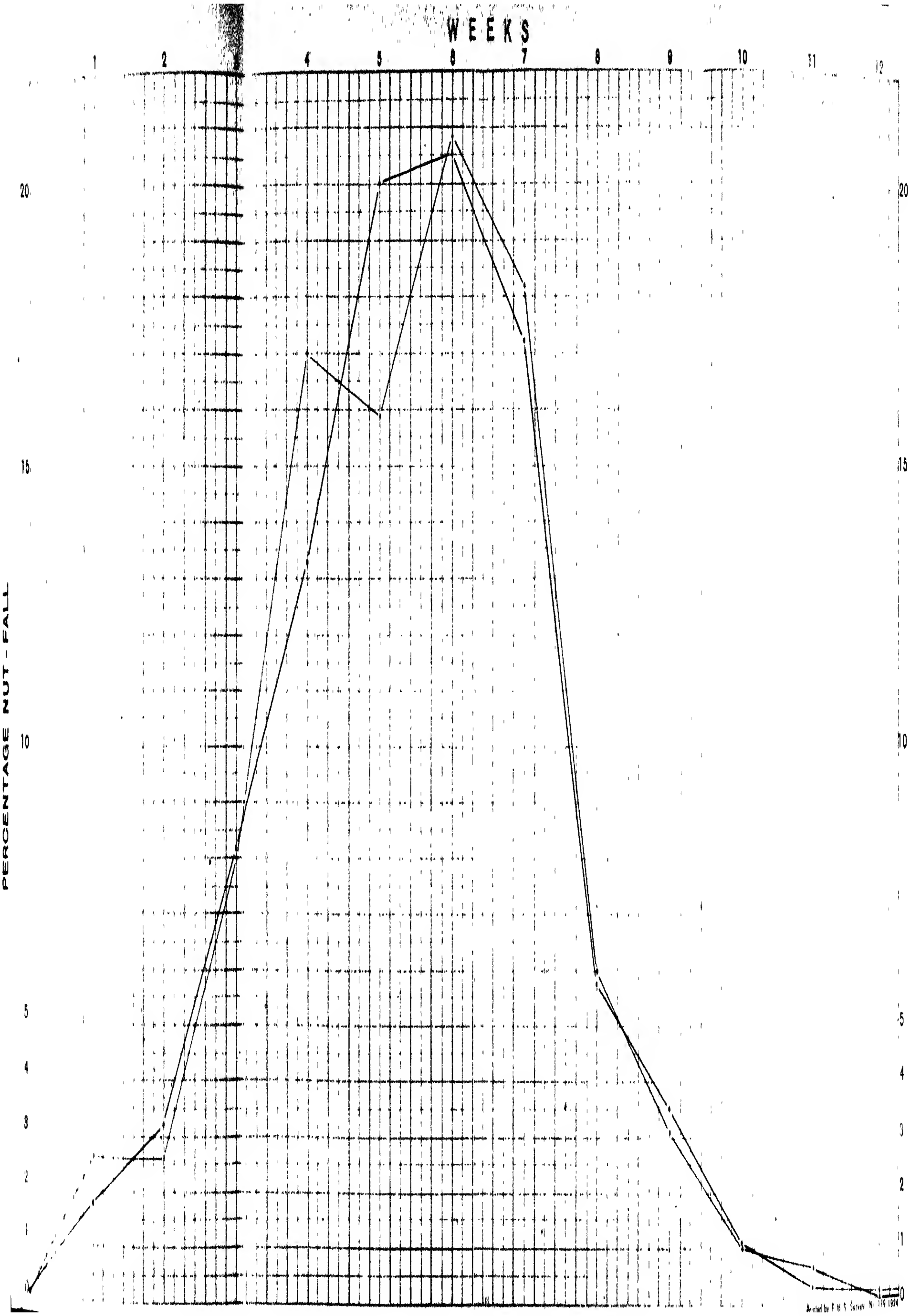
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EXPLORATION OF THE PERAK-PAHANG BORDER.*

Extracts from a letter from Mr. W. Cameron to H. E. the Acting Governor (the Hon'ble Cecil C. Smith, C.M.G.,) dated 4th September, 1885.

I have had a very successful expedition this time, and think it is the most complete and comprehensive piece of exploring I have done yet, as well as one likely to lead to practical results.

I have discovered Pahang to be a much larger territory than even I imagined, and I always knew it to be larger than was generally supposed. It impinges right up to the ulu of the Kinta and the Raia close into Perak just as it does at Ginting Bidei, and there is no intermediate nobody's land, except that this portion is totally unknown even to the Pahangites or to any Malays. There is in this place a sort of central hill country, a sort of vortex in the mountains, where for a wide area we have gentle slopes and pamah (plateau) land with round hills shut in all round by loftier ranges but which from the mean elevation of this vortex appear comparatively low, but the mean of the valley for many miles is 4,500 to 4,750 feet above sea level by aneroid. Streams of considerable size glide along easily from all around and go to feed one large stream eventually, and this is the Telom—the real ulu of the Jelei. I ascended one mountain at the N. E. corner of this Central land and looked down on the N.E. side to the real ulu (upper reaches) of the Kelantan, further east again behind a lofty range, Pahang, octopus-like, shoots out another arm to the north impinging on Kelantan. The mountain which I ascended was 6,300 feet by aneroid, probably considerably higher real altitude, and stands in somewhere about 4°38' North Latitude 10 degrees North of East. Of this a lofty mountain range rises closing in the vortex (to continue the simile) to the East (the vortex being the Telom). This lofty range I estimated to be over 8,000 feet, perhaps considerably more. I dared not ascend it, for not knowing what stream or system of streams I was on, I was obliged to hold on to the water-shed till it brought me right into Pahang known. I had no one who could give me any information, and the Sakias all fled before us, so that I had to be my own guide, and thus, as I say, was tied to this water-shed till I could make sure what it was, as I felt certain it would settle the question of the central watershed about which there have been various conjectures and it has solved the question, at least up to this point and a good way north of it.

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* These articles are reprinted at the request of the Hon. the Chief Secretary to Government. Mr. W. G. Maxwell C.M.G. It must be understood that the reprint has been made because of the historic interest of the articles, and not with any idea of the endorsement of the statements contained in them.

We had rather a trying time of it, owing to the fearful rains. Colds, fevers and rheumatism were our constant companions, and my men suffered very much.

I hope that I may have an opportunity of placing some of the results of this expedition more fully before you, and thanking you for your kind wishes.

I am etc.

Sd. WILLIAM CAMERON.

P. S.—I was fortunate enough to obtain particularly interesting geological data, of which I have brought many specimens and made copious notes. I should have stated generally that my route was up the Raia which I explored, the Ulu (Upper reaches) being unknown, as well as the Penoh which is an anak (tributary) of the Kinta. I crossed a mountain by a pass 5,300 feet by aneroid lying exactly at the Ulu of the Kinta, Penoh and Telom. This I have called Gunho Pass. I took the elephants over with me, explored this new country and followed the Telom till I got to within a day's sail of the place where it joins the Jelei. Long ere this all our stores but rice had been exhausted so for the purpose of supplies, and also because a rumour had got abroad in Pahang that I was a musoh (enemy) with forty elephants and four hundred men come down to harry and to raid, I had to reassure the authorities: I went down to Toh Kaya's and to Penjum by sampan, then back again and then crossed southerly all the rivers of Upper Pahang, keeping close to the foot of the main ranges and coming out over mountains 5,000 feet high at the Ulu of a tributary of the Slim, and thence on to Bernam.

I have reason to thank the Great Master that I enabled under his protection to bring my men back alive, although I cannot say well, for I on several occasions had great reason to be alarmed and feared some would succumb: there are several of them now under treatment, and one I left in the hospital at Penang.

The elephants, I am happy to say, notwithstanding the unprecedented fatigue, are well and in fair condition. By this time they will be pretty strong, for I left them at the Ulu of Sungkei to feed and rest eight days ago, and they will soon be in good condition. I am starting the relief party back again to-day by way of the Perak river and Batu Gajah and I propose taking a run down to Singapore for a day to get some outfit which cannot be procured here, when I shall do myself the honour of calling on you, but I must start my party first and I will meet them at the Bernam almost as soon as they can get there, as we are taking an additional elephant.

Intd. WILLIAM CAMERON.

ACCOUNT OF AN EXPEDITION.

To the Batang Padang Mountains, Perak, to Report on the Suitability of the Land for Planting Purposes.

By Mr. J. M. E. Cock,
Superintendent Government Plantations,
(*Perak Annual Hand Book and Civil Service List* 1892.)

In accordance with instructions received from H. B. M.'s Resident, on 16th March, I left Padang Rengas on the morning of the 18th to proceed on an expedition to explore the high mountains between Kinta and Batang Padang with a view to ascertain the suitability of the country for tropical agriculture, and, if practicable, to reach the plateau described by the late Mr. Cameron.

Mr. Fraser, of Waterloo Estate, a planter of many years' experience, accompanied me.

We proceeded via Penang, and arrived at Teluk Anson on the morning of Thursday, 24th. With Mr. Bowen's assistance, we secured a boat, and left Durien Sabatang at 6.45 a.m. 25th, reaching Tapah at 10 a.m. 27th *i.e.*, in two days 3¼ hours. We had been informed at Teluk Anson by the Superintendent of Lower Perak that Mr. Wray, the Collector and Magistrate of Batang Padang, was not expected back from Slim for some days.

We first went with Mr. West along the Chanderiang Road where his coolies were working.

We were favourably impressed with the soil and lie of land, unquestionably suitable for tea, Liberian coffee, and I presume, pepper. The banks of the cart road at present being cut by Mr. West through this land gives abundant evidence of quality and depth of soil, a free loam to an average depth of six feet where the coolies were working.

Next day Mr. West took us along through the Jungka Valley (well known for its mines rich in tin and also gold) towards Bidor to meet Mr. Wray. We met him about six miles along the road, when we all returned to Tapah. The Magistrate on his return found that he had to go to Chanderiang, so I accompanied him that evening, with the view of seeing as much of the country as possible. Returned on Wednesday, after examining the mines. We passed through a well-watered country, with rich soil, well adapted to grow coffee, tea, and probably pepper and cacao. The cart road under construction will develop this land, and, if taken up by planters at once, squatters will be prevented from occupying the best sites and cultivating the most favoured spots.

On his arrival from Bidor Mr. Wray had sent Penghulu Toh Baias to arrange about Sakeis (the aborigines of the country) as

baggage-bearers, and on Thursday the Penghulu came to report that we should be able to start on Saturday. Three elephants sent from Kinta by the Magistrate arrived this day, 31st March.

After a careful examination of the mountains from the Magistrate's bungalow, we resolved to ascend Gunong Batu Puteh first, to see the nature of the country, and from a prominent point to lay out our line of march for future operations.

We left Tapah on the afternoon of Saturday, 2nd April, passed through Kampong Brunen, Dan Dewa Sakti's home, where we saw mango trees growing from the seed which had been given him by the Resident on a visit in 1880. Reached Kuala Woh in the evening. The country we passed through on the north bank of the Batang Padang is drained by no less than fourteen streams.

On Sunday, marching along the north bank of Sungei Woh, we saw some good soil, but the subsoil was generally rather light and sandy. Mr. Wray was indisposed, and the elephants were making bad progress, so we halted at Batu Kacha about 1 p.m.

On Monday, 4th, Mr. Wray was much better. We sent Sakeis to bring up the goods from the elephants, sent elephants back to Kinta with a letter of explanation to Mr. Leech, established a depot at Batu Kacha, and proceeded on our way to the foot of Batu Puteh. We found Penghulu Toh Baias, who had been sent on before on purpose, had chosen a beautiful site for our camp on the bank of the Woh. This stream is famed for its turbulent, icy cold water. We had bathed and were making ourselves comfortable for the night when we observed the water come down in a wave about eighteen inches high, followed by another three feet high. In a quarter of an hour the water had risen 7½ feet above its former level.

Next morning (5th) started up the mountain. At the base passed through fine land, heavily timbered and well watered: would grow fine tea, pepper, cloves, cacao, &c. The rest of the day's march was over country too steep, in my estimation, for profitable cultivation After five hours steady walking, we reached the late Father Scortechini's last camp, and were told that we were close to the top of the mountain. I went up after a short rest, and with some trouble got to the summit, only to find that there were mountains about 1,500 feet above me. The scene as viewed by me from a pinnacle of about ten feet square, my only companions a couple of shivering Sakeis, was indescribably solemn and grand. To the south, mountain on mountain extending down to the Slim; to the east, two tall mountains towering aloft shut out the view; high mountains to the north, almost continuous to Bujong Malaka on the north-west; and to the west open plain to the sea, the valley of the Batang Padang, Kinta and Perak rivers. Glimpses only of this to be had through the driving mist.

We were stirring betimes next morning (6th) and went to the top of the mountain, Toh Baias, in fear for our safety, having sent Sakeis on ahead to make ladders of rattan and cross sticks for the

steep portions. From the top we had an extensive and clear view of the valley of the Batang Padang, of Tapah, Jungka valley, &c. Mr. Wray took a few bearings, none too soon, as the mist was on us in a short time. We estimated the height of the mountain at 4,500 feet, and I have heard subsequently from Mr. Wray that he and his brother the Curator make it out to be 4,750 feet above sea level. In a southerly direction on the hills I have described as stretching towards Slim there is a good piece of undulating land at from 2,000 to 3,500 feet elevation, out of which about a thousand acres at least might be got suitable for cultivation. Again, in a south-westerly direction in a line with Tapah, at from 1,500 feet to 2,000 feet, a similar area is available. The land in the immediate neighbourhood of the mountain is too steep, in our opinion for agriculture. We judged it was quite unnecessary to make for the top of the true Gunong Batu Puteh, as from our elevated position we commanded a view of all the neighbouring mountains sufficient to enable us to decide upon our future course. The decision we came to was to make for the ulus of (1) the Woh and (2) Batang Padang. We were guided to choose those routes as they seemed most likely to lead us into coffee lands.

Struck camp at 12.30 p.m. and reached the camp at the bottom of the mountain in good time, bringing with us specimens of orchids from the trees and ground, also two varieties of adiantum, be. onias, &c.

On Thursday, 7th we received supplies from depot at Batu Kacha; started in soaking rain up the south bank of the Woh; marched steadily on, fortunately leaving the rain behind, and arrived at camp at four o'clock. We camped at the base of a gigantic isolated block of granite, and were so well protected by the projecting top of concave face, that, though it rained during the night, we and our followers did not suffer. In front of our camp was a fine clump of giant bamboo, a cross section of the best joints being about six inches in diameter. The Sakeis called the camp in Malay Gua Basah (Anglice, Damp Cave), and the shelter rock Burong Gigit (Bird's Tooth). We were charmed with the shelter rock and its surroundings, and decided he would be a fortunate man who had an opportunity of opening a coffee estate there. The soil and jungle are both fine, the elevation about 3,000 feet, and a stream of water, cool and clear as crystal, within five minutes' walk of the Gua Basah. The soil may be classed as argillaceous free, dark on the surface from admixture of decomposed vegetable matter, and throughout of very superior quality.

For about two hours on Good Friday we marched through nice undulating land, soil rich, of good depth, elevation 3,000 to 4,000 feet; abundant water supply. Above 4,000 feet on this mountain the ground is steep, soil poorish, and jungle inferior, full of excellent rattan, which is useful in many ways on a coffee estate. Our baggage bearers halted at noon, commenced clearing away jungle so as to form a safe place for camp, and if possible get our clothes dried—we got soaking wet every day but one during this expedition. Our guides told us we were at the source of the Woh, and that the pass to Pahang

was close to us. Mr. Fraser had come bravely along, shivering with fever the most of the way from the camp of the previous night; so we left him and Toh Baias in charge of camp and started for the pass. Judging from glimpses we had of the country as we came along (we had been looking out anxiously for the pass) we were rather surprised when our guides took us up a steep face to the top of Gunong B'rapit. The way was materially shortened by the beauty of the surrounding jungle. As we ascended the trees became stunted, and covered with heavy loads of trailing mosses of different varieties. Embedded in the mosses were orchids innumerable, many of which were in flower. A bright sun was shining, pleasant breeze blowing, and the lovely valley of Pahang lay beneath us. Mr. Wray was soon busy with pencil and prismatic, but the clouds were on us shortly, and we had to desist from labour. To secure the advantage of commencing operations at dawn next morning, we resolved to camp on the top of the mountain. Accordingly, sent down our followers for provisions and what water-proof sheets could be spared from the camp, while we cut sticks to make a sort of gipsy-tent Weather threatening when we went to sleep at dark, we were awakened in a couple of hours by a howling tempest of wind and rain: we thought we should be swept from the top of the mountain. We considered it advisable to shift from the most prominent point, the more so as we had noticed before it was dark the summit had a lightning-scathed appearance. Spent a miserable night, and were glad to get up and stretch our cramped limbs some time before dawn There was a glorious sunrise; and a gorgeous panorama unfolded itself to our view.

Morning of 9th April. The Pahang country gets the first of the sun, and the advantage of this can be easily traced in the finer jungle on the eastern slopes as compared with the western. On the eastern side of the range, too, the jungle appears to roll on gently and gracefully--a contrast to the rugged though more picturesque view on the western ranges. It has therefore many natural advantages for agricultural enterprise. Mr. Wray having resumed his labours of the previous day, about noon, we had a lasting record of the principal features to the north, west, and south from this mountain. We reached the camp shortly after mid-day, and after refreshments busied ourselves arranging the rich spoils from the jungle in the shape of orchids, adiantums, &c.

Mr. Fraser accompanied us up next morning, 9th, as also did Toh Baias. Gunong B'rapit is about 5,000 feet above sea level, pass below into Pahang less than 1,000 feet. Mr. Fraser agrees with me that on the eastern slope fine land for coffee is to be had, with everything in its favour if a little more accessible. We saw Gunong Hifan bearing 310 deg., Waterloo 307 deg., Bubu 299½ deg, Kledang 303½ deg, and in valley of the Batang Padang a promising looking block of land which we called the Horse-Shoe Valley, with eastern aspect and apparently from 2,000 to 3,000 feet elevation. This block, which is not very extensive, and the land in the neighbourhood of the Goah Basa, already described, seemed to be the most tempting for cultivation of Arabian coffee, but, if a commencement were made, it would be difficult to say what land would and what land would not be opened, as steepish lands possess advantages which make practical

planters value them quite as highly as land of easy lie. We had accomplished our object in exploring the Ulu of the Woh. Our next was to make for Ulu Batang Padang. This we wished to do by marching north over the mountains either by the western or eastern slope. When Penghulu Toh Baias heard of our intention he said the thing was impracticable, there being no tracks. On our proposing to cut a track he said the Sakeis declined to accompany us, and no amount of persuasion would move them ; so reluctantly we were compelled to return by the route we came. It was easily seen that all the Penghulu's knowledge of the country was derived from the Sakeis, and, very properly, he was always accompanied by one or two Sakeis who knew the country.

We left on the morning of Monday, 11th, and reached Tapah on the evening of the 12th.

Mr. Fraser, who had thoroughly enjoyed his trip, and whose knowledge and experience had been of great assistance to me in forming an opinion on the capabilities of the country we had passed through, considered it his duty to return to his charge at Waterloo from this point, much disappointed at not being able to explore further.

Penghulu Datoh Toh Baias as far as Batu Puteh was energetic and helpful ; after that stage his energy flagged, and he seemed to enter a passive protest against the expedition proceeding further. This arose from the conservatism innate in most Malays : he desired that things should remain as they were, and saw elements of change and confusion invading his territory in the shape of the members of this expedition. His action threw us in more direct contact with the Sakeis, and we found that several of them could talk Malay fairly well. All through the expedition the Sakeis behaved splendidly. They are an active, hardy race, many of them of fine physique, deep-chested, and strong limbed. They will play an important part in the future development of the resources of the country.

Our followers did not reach Tapah till the day after our arrival, and then dispersed to their several homes.

All the Penghulu's fire and energy were excited in collecting a force for the second expedition, but it took him some time to get a band together.

We left Tapah on the 16th, and after waiting a day at Kwala Woh, on Monday, 18th, we accomplished a short days' march along the north bank of the Woh to Luba Manoh, where we arrived at noon. The country we traversed was well suited for tea cultivation, soil good and deep, and, apparently, from the number of streams crossed, rainfall abundant. Left Sakeis making huts, and accompanied Toh Baias to Lumpong, where he went to procure extra men.

On the 19th we passed through some fine country, abundantly watered, and arrived at camp rather late in the afternoon.

On the 20th Mr. Wray found his ankle so painful, having twisted it on our rather rough journey the day before, that he could not put his foot to the ground. I left for the hill above our camp, on the other side of which we expected to find the horse-shoe valley observed by us from the top of Gunong B'rappit on the morning of the 9th. Datoh Toh Baias and Klana, Mr. Wray's krani—a first rate jungle man—and Sakeis accompanied me. We could see very little from the top of this mountain, on account of high jungle, very steep on the western side. We returned to camp at 4 p.m., in pouring rain.

On the 22nd Mr. Wray was fit for travel again. We proceeded through some very fine land, leaving Sungei Batang Padang behind us, and camped on the banks of Sungei Singum. The land here is worth more than a passing notice. We had come through the valley of the junction of the Sikum and Singum with the river Batang Padang. The country was apparently more open, and the soil richer than anything we had seen before on this journey, with exception of some of the land we saw on the 19th. The surface soil is rich and dark, the subsoil deep, rather yellowish, of a loamy nature. This is unquestionably a soil of great fertility : tea would certainly flourish in it, and would find no obstacle in the way of throwing its strong-growing tap-root deep into the ground. I have seen cacao grow well in soil inferior to this. Here and there boulders of rock cropped up, which, without interfering at all with the depth, improved the quality of the soil, their gradual detrition adding mineral wealth to the vegetable mould deposited by the luxuriant jungle. On enquiry we found that our guides had left the valley of the Batang Padang and taken us up the Singum, near the source of which lay the Laut Tungal or Solitary Sea, as it may be freely interpreted, the locality of which had been pointed out to us from Gunong B'rapit.

On the 23rd, as our object was to explore as much of the country as possible and as quickly as possible, we sent the main body to take up their quarters on the Batang Padang, while we started in light marching order (with nothing but our instruments) up the Singum. The line of march in the early part of the day took as through country the most of which had been cleared by Sakeis, on which jungle of a secondary growth had sprung up. The original forest, where it existed, was fine, and we saw great tracts of it lying in a north-westerly direction.

From Gunong Chenum Prah we got a good view of the country, and could see that all the best land in the valley between us and Ulu Woh had been under cultivation. We formed a very favourable impression of the soil from a Sakei ladang we passed through, where tapioca and other food stuffs were flourishing in a good black loam. On reaching the Laut Tungal we found it was marsh, as we had suspected, surrounded by heavily-wooded hills. We returned through a smart rain-storm to our deserted camp on the Singum, and on to the new camp on the Batang Padang. The Laut Tungal may be put down at from 3,000 to 3,250 feet above sea level. The soil is good, and the day may not be far distant when there will be a branch road leading up the valley of the Singum through estates of tea and coffee.

We had become pretty well accustomed to wading up the beds of streams and scrambling over slippery rocks, but the route of this Sunday, being principally up the bed of the Batang Padang, was particulary rough. Our view was intercepted by the steep banks of the river, and we did not see much of the country.

On Monday (25th) morning, which was bright and fine, we came to a place where the Batang Padang tumbles over a succession of precipices, first one then another, and at last there is a sheer fall of over a hundred feet, forming a beautiful waterfall, the spray from which was to be seen glistening in the morning sun for a considerable distance. We named it the Bridal Veil Fall. We then scrambled up the steep side of the ravine, crossed the stream at the top of the falls, and up a very steep hill-side, seeing some good country stretching towards the west in the direction of the Ulu Singum. Struck the valley of the Batang Padang again, and reached the spot selected for a camp for the night. We could see we were not far from the source of the Batang Padang, the volume of water being so very considerably reduced. We left the men forming camp and went straight up the hill in front of us. Soon found ourselves in the region of dychridiums and orchids similar to those found at Gunong B'rapit of the Ulu Woh. Marched on in hopes of reaching an eminence whence we could obtain a view. Without any very appreciable alteration in altitude, we entered a region well watered, with rich soil and magnificent timber. We both agreed it was the finest forest we had ever seen. We ourselves decided on our route for the following day, after finding the old Sakei guide was beyond the limit of country known to him. Returned to camp just before dark, well pleased with our afternoon's work.

Left a most uncomfortable camp next morning early, and proceeded rapidly over country traversed the previous afternoon. Found little Sakei boy and one of our followers sitting up a tree watching the monkeys that were holding high chorus in the neighbouring trees, and, by questioning him, gathered sufficient information to make us wish for more, so Klana went up a high tree (being an old sailor, this was an easy matter for him). He took his bearings for the highest mountain to be seen, and led the way in a more northerly direction than we had intended. The result proved he was right, for we were not long in reaching the top of a high mountain, and his skill, combined with the industry of the Sakeis, soon afforded us a ricketty ladder up a monster tree. From these we saw a higher mountain ahead of us, in an easterly direction. Dispatched impedimenta in charge of Datoh, who undertook to find water and make a camp while we and Klana struck right up the mountain ahead, full of hope we had reached the Gunong Brambun the Resident had viewed from Tapah. We had some hard cutting through rattan before we reached the top of the mountain. This hill had high trees right on the top, so we could do nothing more than fix on a good tree on which to erect a "crow's nest" next morning. The trees were festooned with moss, and almost every tree had its quota of orchids, many of which we were fortunate enough to see in flower. We reached the camp in the evening, which was situated at the very source of the Batang Padang. We congratulated ourselves on having carried on our expedition so far successfully.

Wednesday, 27th, made an early start, accompanied by Klana and eight Sakeis, to the point we had gained the previous evening. Klana made a crow's-nest, which reflected great credit on his skill. A driving mist gave us only passing glimpses of the surrounding country, and it was only after exercising great patience that we got a sketch of the country, and took bearings. Another crow's-nest had to be made on a mountain immediately south of us in order to see the country on that side. Waited on till past four in the hope of getting a clear view, in vain.

Next morning, Thursday, we were early at our point of vantage, and had a glorious view of the country from an elevation of apparently close on 5,000 feet: mountains surrounded us. The country to south and south-west we had seen most of from Batu Puteh and Gunong B'rapit. Beneath us was the pass into Pahang, at the source of the Sikum: from the nature of the ground, we judged it was about 1,500 feet below us. Some easy slopes on the eastern exposure of those southern mountains were suited in every way for coffee cultivation. Turning north-east we looked straight at what was probably pointed out to the Resident as Gunong Brambun, it being the highest mountain near us; to the north and west a great extent of easy, billowy land, delightful to the eye of a coffee planter; heavy forest, well watered, and open to the morning sun.

To arrive at an estimate of acreage we saw and to give an idea of the nature of the country, I will compare it to the well-known and much-visited coffee district in Ceylon-Dimbula, as viewed from the Dimbula Gap, looking south-east towards Manoya--the same broken, rugged outline bounding each, the mountains running down to the low country, in the case of the Brumbun district (as it may not inappropriately becalled), the same as happens in the Dimbula Valley at Meddecoombera. The extent of country seen may be safely put down at thirty miles long, and, though as broad as five miles in places, owing to the broken nature of the country, it would not be safe at present to estimate more than 30,000 acres available for cultivation, though when every separate valley in this large district is surveyed very likely three times this extent will be developed. From a very rough sketch the late Mr. Cameron made to show me the position of the land he discovered, and from a letter written by him which appears in the Straits Asiatic Journal, June, 1885 (for extract from which I am obliged to Mr. Wray) I gather that we were very much south of the land he means. It is just probable we saw it in the distance, and that it formed the extreme northern end of the country we looked into.

This is unquestionably the coffee district of the State. Other places are more accessible, but the area is very limited. Here the extent is vast; and when one considers what has been done in Ceylon by the State and by private enterprise in opening up communication with mountainous regions, without looking at the political importance of having a highway into the important eastern State of the Peninsula, the task before us here is comparatively speaking, easy.

The soil all over this State upon the hills is deep and rich, and on the Batang Padang mountains is of a very superior quality. Sir Graham Elphinstone, when he visited the Waterloo estate in 1884, remarked particularly on the admirable quality and freeness of the soil there, especially on the eastern slopes. Again in March, 1886, when he visited the Government experimental plantation near the Hermitage, he was equally pleased with the soil, and classed it as a sandy loam

In estimating elevations we had to be guided by our own experience by the nature of the herbage, and by comparison with mountains of fixed altitude. The figures given by the aneroid kindly lent me by Mr. Mais, of the Survey Office, Taiping (and about which he warned me) are apparently correct up to a certain height, but beyond that are entirely unreliable.

The Hermitage, 23rd August, 1887.

PAPAIN.

By B. J. Eaton.

ARTICLES on "Papain, its production and uses" and "The Preparation of Commercial Papain" were published by the writer in the Agricultural Bulletin, Vol. II, No. 7, February 1914, pp. 190—192 and Vol. V, Nos. 5 and 6 February—March, 1917, pp. 202 -203.

The information contained in the present article embodies that previously published, together with additional information from other sources and replies received from various firms in England, Canada and America which are interested in this product.

Source of Raw Products.—Papain is a proteolytic or digestive enzyme contained in the juice of the fruit and other parts of the Papaya tree (*Carica* papaya).

The commercial product, which consists of a cream coloured or white powder is obtained from the fruit of the tree.

Cultivation.—The papaya tree, as is well know, grows extensively in Malaya and other eastern tropical countries and other parts of the tropics, including tropical Australia and is grown largely for its fruit.

There are three kinds of trees (*a*) hermaphrodite or perfect flower (*b*) female or pistillate (*c*) male or staminate. The trees are propagated from seed, which should be sown in a well prepared seed bed about ½ inch apart. The seeds should be covered lightly with soil and the seed beds should be well watered The beds should be shaded and, if the seeds are sown during rain, the beds should be sufficiently protected to prevent the washing away of the seeds.

The seeds germinate in about 2 -4 weeks and may be transplanted when about 3 inches high. The plants should be watered before transplanting and three fourths of the leaf blades should be removed to prevent wilting. The soil should be well pressed round the roots and the seedlings planted at about 10 feet apart. Cover crops may be grown on the land. Water should be supplied, if the plants tend to wilt. The plants however will not tolerate a water-logged soil. The trees begin to bear fruit after about one year and the fruit may be tapped to obtain the juice when they are three months old. Only mature, but not ripe, fruit should be tapped.

Cattle manure is applied largely in India in the cultivation of the tree. The following mixed fertiliser has also been found to be very successful in Hawaii—Superphosphate 800 lbs., sulphate of potash 315 lbs., nitrate of soda 250 lbs., sulphate of ammonia 190 lbs., volcanic ash 445 lbs. Ploughing and harrowing during the early stages of growth, are also recommended in India.

If properly looked after, the plants may last for 5 to 10 years but the period of profitable production is said to be 3—4 years. Special fruits, varying in size and shape, can be produced by adopting suitable breeding methods.

Composition of Fruit.—Analysis of the fruit has given the following results:—

	Per cent.
Water	90.75
Protein	0.80
Oil or Fat	0.10
Nitrogen Free Extract	6.32
Fibre	1.09
Ash	0.94

The most important constituent is the digestive or proteolytic enzyme—papain.

Preparation of Crude Papain.—The juice, which contains the papain, is obtained by making shallow longitudinal incisions, about 1/8 inch deep, in the unripe but well grown fruits, by means of a non-metallic knife (a bone or ebonite knife). Rustless steel knives will be satisfactory if it is found that they do not discolour the juice.

Fruits, in which only three to four incisions are made simultaneously, can be incised again after a day or two but, if seven to eight incisions are made, subsequent tapping is said to yield very little juice or latex. The juice resembles a white thin sticky latex, which coagulates rapidly.

The fruits should be incised in the early morning and the juice strained through muslin and dried at about 35°C for two days, when it forms a cream coloured brittle mass with an unpleasant odour. The mass can be ground to a powder.

The juice should be collected in glazed earthenware or china cups A trace of formalin added to the juice prevents decomposition. Small quantities of juice may be dried in the sun on sheets of glass. Large quantities however are prepared preferably by spreading the juice on linen trays made by stretching brown linen on wooden frames placed over a hot-air chamber of brick, avoiding excessive heat. This can be done by using an iron plate covered with 2-3 inches of sand between the fire and the hot air chamber, with the trays about one foot above the plate. Artificial drying in this way should be done below 100°C (below 40°C); on a large scale vacuum drying would be found to be very efficient. The juice contracts on drying and the contents of several trays can be placed subsequently in one to complete the drying The juice should be dried till it is crisp and capable of being reduced to a powder. A cream coloured or white powder is obtained.

The yield of crude dried material amounts to about 16-18 per cent. of the weight of the juice.

The yield per tree will depend on locality and amount of fruit. A tree with thirty fruits may yield 1 lb. of crude papain. A dozen shallow cuts about ½-¾ inch part on a fruit of good size will yield ½ oz. of papain.

One authority gives 0.4 lb of fresh latex per tree while 40 fruits have yielded the same amount. In Ceylon the yield is from ½ to ¾ lb. of papain per tree. In India the trees are planted 400 to 500 per acre and the cost of cultivation, collection and preparation of papain is estimated at 200 to 250 rupees per acre.

Purification and Standardisation of Papain.—The commercial product is said to be often adulterated with starches. The "activity" number (i.e. the amount of protein digested in a fixed time at a definite temperature by unit weight of papain) varies considerably.

By Pratt's method (digestibility of casein from milk) commercial samples from Ceylon gave "activity members" from 0.5 to 9.7. Mexican samples have given 12.9 and West Indian samples 40.0. Philippine samples, prepared in the laboratory, of fresh latex (on dry basis) gave 45.8, undried latex (on dry basis) 45.4, alcohol precipitated papain 72.2 and Indian samples 44.4 on egg albumin.

(NOTE :---Pratt uses a 40 per cent solution of a sweetened condensed, skimmed milk as substrate and a 0.5 per cent aqueous solution of papain.

25 ccs of milk, with 23 ccs of water and 2 ccs of a filtered papain solution containing 5.m.grams of papain per c.c mixed and at the end of the digestion period (30 minutes at 40°c) the undigested casein is precipitated by adding 0.5 ccs of copper sulphate solution (6 per cent.) followed by 0.5 ccs of glacial acetic, with vigorous stirring during the precipitation. The precipitated casein is broken up, washed on a filter, dried in an oven and weighed. A blank experiment is used as a control. This method has been adopted by subsequent experimenters in the Philippines, on account of its reliability and simplicity.

Brill and Brown of the Philippine Bureau of Science (The Philippine Journal of Science Vol. 20 No. 2 Feb. 1922 p. 185) state that papain appears to lose its activity on keeping; a sample examined by Pratt in 1914 which digested 85 per cent. of the casein in milk in 30 minutes, had lost all its activity in 1921, although the dried material had been sealed up in small glass vials and protected from sunlight.

These experimenters found that alcohol-precipitated papain is more active than sun-dried papain. By dialysis of the milk (a 10 per cent. solution of a dried milk powder was used, instead of the sweetened condensed skimmed milk employed by Pratt) to remove minerals salts, greater activity was shown.

These experimenters conclude that autolysis of papain takes place at temperatures as low as 0°C when the enzyme is put in water with toluene as an antiseptic. Sodium chloride shows first a slightly activating effect followed by an inhibiting effect in more concentrated solutions; sodium carbonate and bicarbonate and calcium chloride, magnesium sulphate and boric acid have no marked effect; potassium chloride and sodium citrate showed marked activation while acetic and lactic acids showed strong inhibiting effects.

The following method of purification has been applied in India:—20 grammes of fresh latex are stirred with 100 ccs of 95 per cent alcohol producing a white gummy coagulum. The alcohol is poured off and a further 50 ccs of alcohol added to the coagulum, which crumbles to a fine powder. The powder is filtered and washed with ether to remove a semi-solid yellow wax and to facilitate drying. The washed papain is dried in vacuo and gives a pure white-powder, amounting to 3 grammes, equivalent to 15 per cent. on the fresh latex. The papain is tested by using 15 ccs of egg albumin made up to 25 ccs with a 1 per cent solution of sodium chloride to which 1 cc of papain solution (0.01 papain) is added. The mixture is digested for 15 minutes at 80°C. The following results were obtained on different samples of papain :—

(*a*) Juice dried at 35°C, (Neutral). Protein digested 55.9 per cent.

(*b*) Dried juice extracted 10 times with water for 6 hours and filtered; extract precipitated with 2 volumes of 91 per cent. alcohol and dried in desiccator. (Neutral.) Protein digested 51.0 per cent.

(*c*) Fresh latex precipitated with 2½ volumes of 91 per cent. alcohol and dried in desiccator. (Neutral). Protein digested 56.8 per cent.

(*d*) Latex treated as in (c) and then washed with ether after drying for one day and then dried in desccator. (Neutral). Protein digested 67.1 per cent.

(*e*) Fresh latex precipitated with 5 volumes of 94 per cent. alcohol and washed three times with ether, and dried in desiccator. (Neutral). Protein digested 57 7 per cent.

(*f*) As per (e) but solution acid. Protein digested 2.8 per cent.

(*g*) As per (e) but solution acid. Protein digested 2.8 per cent.

These results indicate that the papain prepared from the juice by precipitation with alcohol and subsequent washing with ether gives the most active product.

It will probably however be preferable to leave the purification to the manufacturers who purchase the raw product and to prepare a good dried juice on the estate.

The following points in the preparation should be noted :—

(1) The juice should be dried as soon as possible.

(2) The drying should be effected below 40°C, otherwise the activity of the papain will be reduced or destroyed.

(3) Final drying is effected preferably in a vacuum drier.

(4) The product should be ground to powder and packed at once in air tight stoppered bottles or lead-lined wooden boxes.

Further experiments indicated a remarkable activity when the digestion of the protein (Egg albumin) was carried out at temperatures as high as 90 to 95°C. in acid or neutral solutions, which seems remarkable.

(*Note.*—Details of the above experiments are contained in " The Phillippine Journal of Science Vol. 20, No. 2, February 1922 p. 185 and " The Agricultural Journal of India Vol. XVI, No. 5, Sept. 1921).

Markets & Value.—The following information has been received in reply to a questionnaire addressed to various firms in England, Canada and America

Firm A. (New York. U.S.A.) Imports into United States of America for year ending June 30th 1914. Papain extract—39,419 lbs. valued at $74,866 gold. From Germany 94 per cent, From England 6 per cent. Papain "select"—6, 181 lbs. valued at $26,613 gold.

Germany—89 per cent, Holland—8 per cent, British West Indies—3 per cent.

The product described as "Select" is probably a dry crude papain. The crude papain, which is now imported, is packed in bags and fetches $1.50 to $1.75 per lb. C.I.F. New York (December 1922). It is usually sold on test. The amount imported at present is probably about 50,000 lbs. per annum.

Firm B. (England). No information of any value.

Firm C. (Canada). The dried juice should be packed in a tin, glass or jar container and sealed. The product should be bone-dry.

This firm imports juice from its own estates, packed in ordinary kerosene or gasoline tins.

Firm D. (England) This firm quotes prices from four different wholesale lists as follows :—(A) 3/2 per oz. (B) 2/6 per oz. (C) 3/2 per oz. Merck's-22/2 per lb.

Firm E. (England) No information of any value, except as to packing in air-tight containers. This firm states that there is a very restricted market in London, as papain seems to have largely gone out of use in medicinal preparations.

Firm F. (England) Market price (Sept. 1922) 7/8 per lb. The product should be packed in lead lined cases, containing about 56 lbs. There is a fairly good demand for the product, which is sold on test. It should be free from sugar and starch.

Probably between 250 & 500 lbs. per month could be taken.

Firm. G. (England)--branch of New York Firm A.--Market in London very limited and consignments sent to England appear to have been chiefly exported again. The United States of America the chief consuming country.

The above replies appear to indicate that the chief consuming country is America.

The present price of this product is 3/2 per oz. in London and \$2/15 to \$2/25 gold per lb. in 10 lbs. bottle (U. S. Pharmacopoeia) Powder or \$1/85 to \$1/90 per lb. Crude, in 150 lb. cases.

Conclusions.--The cultivation of the Papaya tree for the production of papain should be an economic proposition on a small scale. The plants could be grown with other crops; coffee, or Kapok could be grown if the papaya tree are planted widely.

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CASHEW NUT OIL.

By C. D. V. Georgi.

IN a previous number of the Malayan Agricultural Journal, Vol. X, Nos. 10, 11, 12, October, November, December 1922 an account was given of some experiments which had been carried out with Cashew nut oil, as a result of a suggestion that it might be possible to utilise this oil in pharmaceutical preparations in a similar way to Almond oil. Samples of the oil, both crude and refined by caustic soda to remove the free fatty acids, prepared in this department were sent to the Malay States Information Agency, London for valuation.

Results of Examination.

Samples of the crude and refined oils were submitted by the Agency to the Imperial Institute for examination. An extract from their report is as follows:—

> "These results (physical and chemical constants of the oil, compare table in article referred to above) show that the cashew kernel oil closely resembles almond oil in most of its constants, but that there is a wide difference in the solidifying points of the fatty acids obtained from the two oils.
>
> The samples of both the crude and purified oils were submitted to the test specified for almond oil by the British Pharmacopoeia *viz.* that the oil must remain clear after exposure for 3 hours to a temperature of $-10^{\circ}C$, and should not congeal until about $-18^{\circ}C$. In both cases however the cashew kernel oil failed to comply with these requirements."

Another point noted by the Imperial Institute was the large amount of stearine (solid fat) which had separated from the oil. This separation takes place only in a cold climate, as in this country cashew nut oil will remain quite clear, even after standing for a year.

Conclusions.

The conclusions arrived at by the Imperial Institute are as follows:—

> "The results of chemical examination show that cashew kernel oil, after refining with soda and partially removing stearine, could be used as an edible oil. In view however of the high price realised by cashew kernels in the United Kingdom for confectionary and dessert purposes, *viz.* about

£8 per cwt. (December, 1923.), it is probable that it would be more profitable to export the kernels than the oil.

Neither the crude nor the purified oil would be suitable for use in Pharmacy as a substitute for almond oil, as the cashew kernel oil does not possess all the properties of almond oil."

Received for publication 12th February 1924.

NOTE ON THE USES OF RAW RUBBER.

By B. J. Eaton and J. H. Dennett.

EXPERIMENTS are being carried out in the Chemical Division of the Department of Agriculture on the effect of exposure of various types of raw rubber to atmospheric conditions.

In these experiments the samples of rubber are being dusted with various powders and sulphur is also being incorporated in samples.

Although the experiments are not yet complete, they shew (a) that smoked sheet is superior to unsmoked sheet and crepe in resisting atmospheric conditions. (b) that the dusting of powders over the surface of the rubber has a protective effect.

It has also been found that rubber with which sulphur or antimony sulphide (which contains free sulphur) is incorporated is much more resistant than raw rubber. A sample of crepe rubber, containing about 4 per cent. of sulphur incorporated on an ordinary crepeing machine, after exposure for six months with no protection, exhibits no sign of tackiness, but the rubber feels slightly harsh to the touch.

The reason for this is possibly solar vulcanisation. Luff in a recent communication in the India Rubber Journal, has shewn that sulphur will combine with rubber under such conditions.

The incorporation of sulphur with pale crepe in the manufacture of pale crepe soles will therefore probably produce a product which may be superior to the raw crepe sole. The incorporation of about 4 per cent of sulphur gives a slightly yellowish tinge to the rubber. Similarly black soles for use on black boots can be made by incorporating lampblack and sulphur while red soles for brown boots and shoes can be made by mixing a small proportion of antimony sulphide with the raw rubber. These chemicals can be incorporated on the crepeing rolls without affecting the final character of the sole crepe.

Samples of such soles have been prepared and sent to the Agricultural Section of the Malayan Pavilion of the British Empire Exhibition.

A sample of smoked sheet has been used on the footboard of his car by an officer in the Federated Malay States Railways' Department for about eighteen months and at the request of the Secretary for Agriculture was examined recently by one of us.

The following observations were made :—

> The rubber shewed no signs of wear but had developed (a) a permanent set (b) softening and loss of a considerable proportion of its original resilience.

Permanent set takes place very readily in raw rubber, owing to its comparatively poor elastic properties. The effect of a periodic load of about 150 lbs. on the rubber had produced this permanent set. This set however is not of great importance in the case of rubber used for such a purpose. The softening and loss of resilience is due to the exposure to the atmosphere.

The most important feature however is the fact that the sample has not become "tacky." This is due to the facts mentioned in our experiments above viz. (1) smoked sheet is more resistant than crepe in this respect and (2) the continuous covering of the surface of the rubber with fine dust particles, which confer protective properties on the surface of the rubber. The latter is the chief reason for the absence of the tackiness. The effect of powdering with dust particles is part of a general phenomenon, the protective action of certain powders on the surface of raw rubber, on which investigations are being carried out in the chemical laboratories. The use of pieces of smoked sheet for such purposes is economical and the first cost is very low.

Another use for thin sheets of rubber is the under sides of mudguards of cars. The attrition caused by the impact of small gravel etc., which wears away the paint, is the chief cause of the rusting and perforation of mudguards. If thin sheets of raw rubber are attached to the under sides of such mudguards, they would prevent this attrition and consequent rusting.

One enterprising estate manager has actually made inner tubes of raw rubber and also used raw rubber bands as an extra tread on his tyres

Received for publication 27th February 1924.

NOTES ON THE EXPERIMENTAL PLANTATION, SERDANG FOR THE MONTH OF APRIL, 1924.

NEW planting material received during the month included cuttings of Kikuya grass (*Pennisetum longistylum*) from Ceylon; cuttings of the following grasses.—Australian Blue Couch (*Digitaria didactyla*), *Zoysia pungens*, and a native species known to the Malays as 'terapoh' or 'tebu salak' (*Coelorrachis glandulosa*). Seeds of two cover crops, *Centrosema pubescens* and *Crotalaria anagyroides*, native of South America, were received from the Netherland East Indies. Cuttings of *Mikania scandens*, a twining herb, met with in hedges and the borders of jungle throughout the Peninsula, were obtained from the Experimental Plantations, Kuala Lumpur, for trial as a cover plant. Although not leguminous it is considered to be of possible value as a cover plant on account of its dense habit and rapid growth.

A number of the Candle Nut trees (*Aleurites triloba*) planted out in the field during November 1922, commenced to flower during the month. The seeds of *Aleurites montana*, received from Hong Kong, have now germinated and it is hoped to plant up an area of this tree in the near future. In this connection it is interesting to note that the trees at the Kuala Lumpur Experimental Plantation have flowered irregularly since December, 1923, and apart from its possible value as a crop of economic importance, it is a desirable tree for planting in Malaya on account of its large white flowers, borne in terminal showy masses.

The fifty acre block of African Oil Palms (*Elaeis guineensis*) has been examined for Crown Disease and it is found that 7 per cent. are at present showing signs of this disease. Fortunately the palms appear to suffer no permanent ill-effect and in time recover without any traces of the disease remaining. The disease is common in new areas of this crop in Sumatra and a percentage of 10 per cent. of diseased palms is frequently seen.

Rain fell on 22 days during the month giving a total rainfall of 18.31 inches. The heaviest rainfall in 24 hours was 1.3 inches on the 8th on the month. These are the highest totals yet recorded on the plantation for any one month and any one day.

The maximum shade temperature was 95° F. and the minimum 69° F. The average maximum shade temperature was 92° F. and the average minimum 71.4° F.

The total run of wind during the month was 1470.4 miles, and the average run for 12 hours from 6 a.m to 6 p.m. was 39.42 miles and that from 6 p.m. to 6 a.m. 9.6 miles.

(5-5-24).

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OIL PALM IN MALAYA.

By B. Bunting and C. D. V. Georgi.

THE Oil Palm, *Elaeis guineensis*, the fruit of which yields the two well-known oils of commerce, palm oil and palm kernel oil, is indigenous to West Africa. The collection of the fruit and the extraction of the oil are important native industries in those regions.

This palm was introduced into the Netherlands East Indies in 1848, but did not receive serious consideration as a plantation crop until the last decade, when the demand for vegetable oils and fats had increased to such an extent as to encourage the cultivation of oil-yielding crops During this period considerable progress has been made in the Netherlands East Indies where, according to Rutgers,* the area planted with oil palms in the east coast district of Sumatra had increased from 8,500 acres in January 1918 to 28,000 acres in January 1922.

Attention was drawn to the possibilities of this crop by the Department of Agriculture in an article published in the Agricultural Bulletin, Vol. VI, No. 11, September and October 1918. At that period a few acres on one estate had already been planted. Since then the cultivation of the palm has been extended on the estate previously mentioned and other areas have been planted, until at present the total area under cultivation in this country amounts to approximately 5,000 acres, of which 1,000 acres are in bearing. The export of palm oil and palm kernels has already commenced. Numerous applications for land, together with enquiries for information in respect of the cultivation, have recently been made, which show that the possibilities of the crop are now being realised by the local planting community.

A small area at the Government Experimental Plantation, Serdang has also recently been planted with this palm with a view to investigating the various problems connected with its cultivation.

* "Investigation on Oil Palms" by Dr. A. A. L. Rutgers.

VARIETIES.

Although different varieties of oil palm have been described, based primarily on the character and composition of the fruit, it is somewhat doubtful whether there are any definite fixed types, and breeding experiments will have to be carried out to determine this point.

The "Deli" type, which is in general cultivation in Sumatra and this country, is considered to be most suited to local conditions, and it is doubtful whether it will be superseded by other varieties from indigenous palms in West Africa.

The composition of the fruit may vary in respect of (*a*) the percentage of pericarp and its oil content, (*b*) the percentage of kernel and its oil content, (*c*) the thickness of the shell. Improvement may be effected by selection work on the existing varieties, to produce a type with fruit giving (*a*) the maximum amount of pericarp with a high oil content (*b*) a thin shell with the maximum amount of kernel of high oil content. In selecting parent trees, allowance will have to be made for alteration in type due to external environment, which may have a greater effect than genetic constitution.

CULTIVATION.

The most suitable soil for the oil palm is an alluvial loam overlying a clay subsoil, which will permit of easy root penetration and retention of moisture. Light sandy soil or swampy land is unsuitable. Although it may be grown successfully on gently undulating land, the flat coastal land, provided it can be properly drained, is likely to give the best results.

In low-lying land, common in the coastal districts, rantas are first made through the jungle and the main drains cut immediately, in order to dry the land as much as possible before felling is commenced.

The oil palm is propagated from seed, the time taken for germination varying considerably, depending both on age of the seed and method of treatment in the propagating beds. Seeds imported from West Africa, which have dried, or those which are either unripe or over ripe, germinate very slowly, whilst even good ripe seeds obtained locally, when sown as fresh as possible, may by no means germinate rapidly. This is a serious drawback when a definite planting programme has been arranged and, special attention must be given to the method of propagation in order to accelerate germination.

The most satisfactory method of germination is to collect only ripe seeds and, after removing the pericarp, to sow them at once, just below the surface, in specially prepared beds consisting of pure sand about 1 foot deep. The beds are exposed to the sun and kept moist by constant watering. Immediately the two leaf sheaths appear above the surface, which may take from 2 to 3 months, the seedlings are removed from the sand beds and planted about 1 to 1½ feet apart in

specially prepared nursery beds on good flat land. The seedlings remain in these beds until ready for transplanting into the field, which may be from 8 to 10 months according to the season when they were planted in the nursery beds.

After felling and burning operations are finished, the land is clean-cleared and prepared for planting. The most suitable distance of planting in the field is 30 ft × 30 ft. triangular (equilateral), giving approximately 55 palms per acre. The area should be carefully lined and holed for planting. The holes, usually 2 feet square and 2 feet deep, are filled with good surface soil and the seedlings planted with the base of the young leaves just above the level of the ground. Deep planting should be avoided. The oil palm stands transplanting fairly well under ordinary conditions, and very little supplying is necessary. After planting, the land should be clean weeded and, to develop the feeding roots, the surface soil at the base of the palm should be kept in a friable condition by digging or forking at least once every three or four months.

As an alternative to clean weeding, leguminous cover crops may be established in the first year of growth. These will reduce the cost of weeding and, at the same time, increase the fertility of the soil. When the young plants begin to develop, growth may be further improved by surface cultivation with ploughs or disc harrows. On peaty land, where the soil is apt to subside after it is opened, mounding or banking of the young plants may be necessary, and this operation may have to be continued until the land has settled down to its normal level. On low-lying land drainage operations will have to be carried out, since the oil palm will not thrive in a water logged soil.

On undulating land steps should be taken to prevent soil wash; this is done preferably by (*a*) planting low-growing cover crops. (*b*) silt-pitting, or (*c*) terracing, all of which tend to arrest the erosion by diminishing the force of rain water which carries away the finer particles of the surface soil.

Although catch crops are not generally recommended, they are sometimes cultivated in the early stages of development in order to provide revenue until the palms come into bearing. On areas where the soil is suitable for the cultivation of coffee, Robusta or its hybrid varieties may be grown with a certain degree of success.

When the palms come into bearing at the end of the third or fourth year after planting in the field, a regular system of pruning the leaves at the base of the palm is necessary. The leaves just below the growing bunches of fruit should not be removed until the fruit is almost ripe and ready for harvesting. The pruning operation should be carried out carefully, since the the fruit production of heavily pruned palms decreases rapidly. Pruning is now practically restricted to the removal of those leaves having a ripe bunch in their axils.

POLLINATION.

Observation on young or isolated palms have shown that natural pollination does not always take place, which has led to experiments

being conducted on artificial pollination. The male and female inflorescences are produced on the same palm, but not necessarily at the same time and, since the flowers on the female inflorescences remain in a receptive condition for a period of only 2 to 3 days after the opening of the flowers, it is frequently necessary to obtain pollen from a male inflorescence on another palm, otherwise the flowers may not be fertilised.

When artificial pollination is necessary, a ripe male inflorescence, denoted by its strong smell of aniseed, is selected; after careful removal from the palm it is held over a funnel and shaken so that the pollen grains fall into a suitable receptacle placed beneath the funnel. The pollen should be collected in the afternoon and dusted on the receptive female inflorescences on the following morning.

While artificial pollination may be advisable in the case of young palms, it may be found unnecessary in the case of older palms which may be pollinated sufficiently by natural agencies. Experiments in artificial pollination have shown that it can be carried to excess, and it remains to be determined to what extent it can be carried out successfully in actual practice over a continuous period. In some cases, more particularly on poor land, over-pollination by artificial methods has resulted both in the reduction of the size of the fruit and the percentage of pericarp.

Special attention will be given to the artificial pollination of the palms planted on the Experimental Plantation, Serdang.

Pests and Diseases.

The oil palm hitherto has not suffered greatly from the attacks of insect pests or fungoid diseases; but the risk of both pests and diseases will naturally be greater when large contiguous areas are planted.

Among insects pests, the coconut beetle (*Oryctes rhinoceros*, Linn.) and the red-stripe weevil (*Rhynchophorus schach*, Oliv.) have been found doing damage, the latter having been known to kill palms by boring through the main stem.

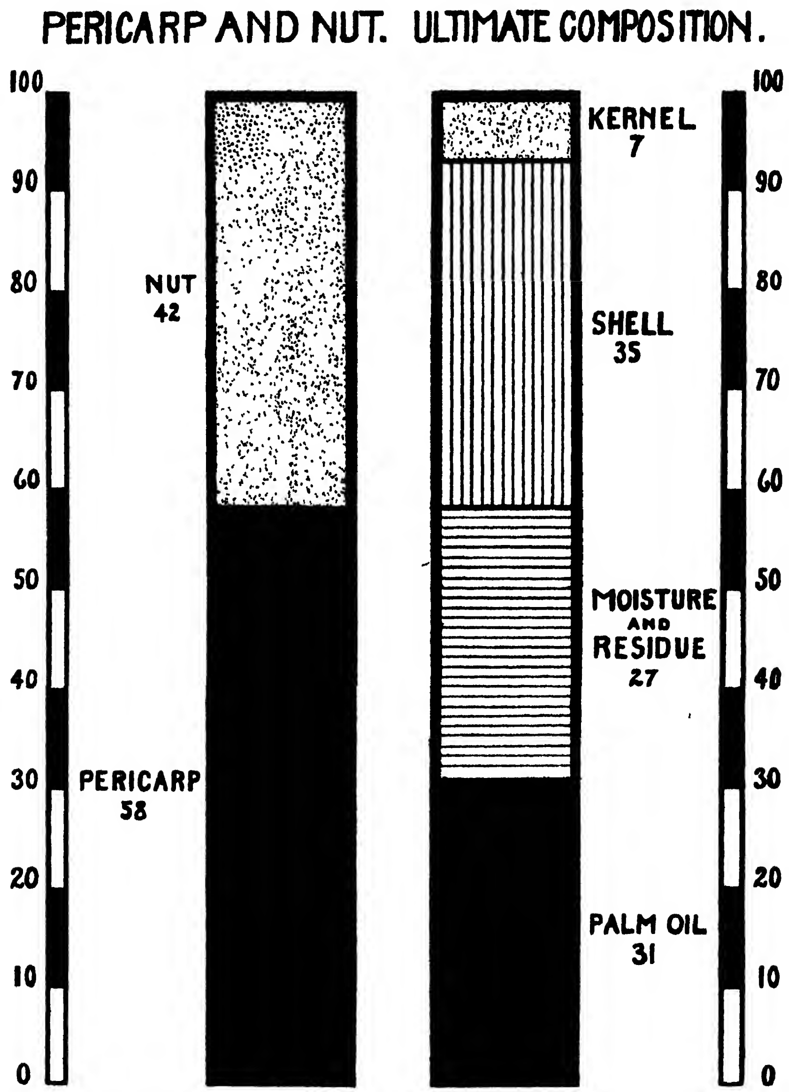
The only disease so far reported, and which appears to be confined to young palms, is the "crown disease." This disease is indicated by a weakening of the leaf stalk of the young leaves, which become bent and fall over, giving the crown a twisted appearance. As a rule, after some time, new leaves are formed and the palm recovers its normal appearance.

Other pests which may be mentioned are rats, pigs and porcupines, which must be exterminated by the usual methods, such as poisoning or trapping.

Harvesting.

As previously stated, the palms come into bearing at about the third or fourth year after planting, and the fruit ripens about six

COMPOSITION OF OIL PALM FRUIT.



months after pollination. The crop is not evenly distributed over the year, the maximum crop being obtained during the dry season and the the minimum during the wet season; the maximum production per month is about double the average monthly production.

The fruit bunches are gathered systematically as soon as they are ripe and conveyed to collecting sheds, in which they are stored on open racks for 3 or 4 days until the fruits fall from the bunch on to trays placed below. The fruit is then collected and transported to the factory, where the oil is extracted. Great care is necessary in the handling of the fresh fruit; under no circumstances should it be allowed to remain in heaps, otherwise fermentation is caused by a fat-splitting enzyme present in the pericarp resulting in a large increase in the acidity of the oil.

Experiments have been carried out at the General Experiment A.V.R.O.S., Medan, Sumatra employing a threshing machine for the mechanical separation of the fruits from the branches, since it has been suggested that, when working on a large scale, the method of first separating the fruits in the field, in addition to requiring the erection of a large number of collecting sheds, may not be practicable.

In these experiments it was found that, although the separation of the fruit could be effected much more rapidly, the fruit was so bruised as to cause a considerable increase in the free fatty acid content. If, however, the branches of fruit were sterilised by immersing in boiling water before passing through the threshing machine it was found that there was no increase in the free fatty acid content of the resultant oil.

As compared with the previous method the disadvantages are that approximately twice as much material (about half being waste) must be transported from the field to the factory and that larger heating vessels are required. The advantages are that no collecting sheds are necessary and that labour is considerably reduced. It is not yet possible to give details in regard to the difference of working costs between these two methods, since the two have not been compared in this country.

Composition of Fruit.

This following table and the chart on the opposite page show the average composition of the fruit from this country.

				per cent.
Fruit	Pericarp 58 per cent.	... ...	Moisture	33
			Palm Oil	53
			Residue	14
				per cent.
	Nut 42 per cent.	Shell 85 per cent.	Palm Kernel Oil	43
		Kernel 15 ,,	Moisture	15
			Residue	42

Proportion of Palm oil on whole fruit = 31 per cent.

Proportion of Kernel on whole fruit = 7 per cent.

Annual Yields of Oil Palms.

Individual palms may produce from 6 to 10 bunches of fruit per annum, whilst the weight of picked fruit may vary from 45 to 145 lbs. per palm per annum according to age.

The following are estimates based on palms planted 55 per acre and calculated on the yields of pericarp, palm oil and kernel given above.

Age of Palm.		Fruits per palm per annum.	Fruit per acre.	Pericarp per acre.	Palm Oil per acre.	Palm Oil Output per acre (85% basis.)	Kernels per acre.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
4th	year	45	2475	1436	767	652	173
5th—7th	„	90	4950	2872	1534	1304	346
8th—10th	„	100	5500	3190	1705	1449	385
11th—15th	„	125	6875	3988	2131	1811	481
16th—30th	„	145	7975	4626	2472	2101	558

The above is a conservative estimate and it is probable that under good conditions these yields will be exceeded.

Extraction of Oil.

The oil palm fruit contains two distinct oils, namely, palm oil, present in the pericarp and palm kernel oil, contained in the kernel. As previously stated, the preliminary treatment of these fruits calls for special attention since there is present in the pericarp an active fat-splitting enzyme. It is important that the fruit be picked when ripe and treated while still fresh, otherwise a large part of the oil will be decomposed, with the formation of an abnormal proportion of free fatty acids. With care, this acidity can be kept below 5 per cent; but if the fruit be left untreated for some time after gathering and the oil extracted by the primitive native method employed in West Africa, boiling out with water, it may contain up to 50 per cent. of free fatty acids.

The method adopted to obtain palm oil of high quality consists in a preliminary heating of the fruit to destroy the ferment; the hot fruit is then pressed in order to obtain as much of the oil as possible without cracking the nut. The partially expressed pericarp is then stripped from the nuts in a special machine known as a depulper or depericarper and, after drying, is pressed again to obtain the remainder

of the oil. The fibrous residue is used as fuel, having no value as a feeding stuff or fertiliser.

Mention might also be made of a modification of the method of extraction involving the use of a centrifugal extractor. In this modified process, the fruits are steamed and charged into the extractor in which the greater proportion of the oil and moisture is removed. The centrifugal action also facilitates the separation of the nuts from the fibrous residue, which is then pressed as described in the process. It may be necessary to treat damaged fruits separately.

The oil is then allowed to settle and is strained into casks for export. Care must be taken in the selection of the casks, oak staves being preferable in order to minimise the loss arising through leakage. Casks of standard size are employed, 10 tons of oil requiring about 15 casks.

Extraction of Kernels.

After separation from the fibre, the nuts are dried and cracked in a nut cracking machine, the kernels being separated from the shells by flotation in brine or clay suspended in water. The kernels are then dried, the shells being used as fuel.

The oil from the kernels is usually obtained by hydraulic expression. The kernels are ground and hot-pressed twice on account of their high oil content. The residue, which still contains a small percentage of oil, is used as a feeding stuff.

In view of the demand for palm kernels in the home markets it is unlikely that palm kernel oil will be manufactured in this country ; ti is therefore preferable to export the dry kernels rather than the oil and cake separately.

Uses.

Palm oil finds a varied application in industry according to its free fatty acid content. While an oil of medium quality is employed largely in the preparation of soaps, candles, lubricating greases and in the manufacture of tinplate, an oil with a minimum quantity of free fatty acids, from 2 to 4 per cent., can be used for edible fats. Hitherto the quantity of such high grade palm oil available has been limited ; but, with regular supplies, it should be able to compete as an edible fat with either coconut or palm kernel oil, since it has been proved that high quality palm oil forms an excellent basis for the preparation of substitute butter and cooking fats.

As stated above, palm kernel oil is used chiefly in the manufacture of edible fats, smaller quantities being employed in the soap making industry. Palm kernel cake constitutes an ingredient of many feeding stuffs.

Value of Products.

The present London quotations (March 1924) for oil palm products are approximately as follows :—

Palm oil (Lagos)	...	£40.5.0 per ton.
Palm kernels	...	£20.0.0 „ „
Palm kernel oil	...	£45.0.0 „ „
Palm kernel cake	...	£ 7.0.0 „ „

The quotation for Lagos palm oil applies to an oil with a free fatty acid content of 18 per cent., calculated as palmitic acid. A premium of 1s. 9d. is paid for each per cent. of acidity below the standard, thus a premium of 15 × 1s. 9d. = £1. 6s. 3d. per ton extra would be paid for an oil of only 8 per cent. acidity. It is possible with careful preparation to keep the acidity of palm oil, produced under plantation conditions, within this limit. This premium for palm oil having a low free fatty acid content was based on the native prepared oil received in the European markets from Africa and is not commensurate with the extra expense involved in the production of such a high grade product as can be prepared under plantation conditions. It is understood that the revision of this premium is at present under consideration.

Conclusions.

From actual experience gained in the cultivation of the oil palm in this country, it is considered that this is a crop well worth development on a plantation scale. The yields recorded locally are sufficiently promising to warrant the outlay of further capital for this industry, and its considered that the return on the capital invested will undoubtedly be greater than that obtained from the cultivation of coconuts. In this connection the details given below, comparing the returns which may be expected under normal conditions from both coconuts and oil palm in full bearing may be of interest. It should be borne in mind that the estimates for the African oil palm are based on figures previously given and are therefore a forecast, since there is no plantation in this country on which the palms are in full bearing.

Returns from Coconuts.—A good coconut plantation in full bearing should produce an average of 60 nuts per palm per annum, which, with 55 palms per acre, will give 3,300 nuts per acre per annum, equivalent to a yield of 16 cwt. of copra per annum.

The actual return from 1 acre of coconuts at current prices would therefore be as follows :—

16 cwt. of Copra at £29.10.0 per ton = £23.12.0.

Returns from Oil Palm.—Reference to the table previously given will show that the estimated yield from palms in full bearing, allowing only 85 per cent. extraction of the theoretical figure for the

oil content, is approximately 18¾ cwt. of palm oil and 5 cwt. of kernels per acre per annum.

The actual return from 1 acre of oil palms at current prices would therefore be as follows:—

18¾ cwt. of Palm oil at £40.5.0 per ton =	£37.14.8
Add premium at 1s. 9d. for 3% acidity =	1. 4.6
5 cwt. of Palm kernels at £20.0.0 per ton =	5. 0.0
	£43.19.2

Although the return from palm oil is considerably greater than that from coconuts exported as copra, it must be remembered that both the preparation of the palm oil and the extraction of the kernels involve a heavy outlay for plant and machinery. This additional expense must therefore be taken into account when making a fair comparison, since no machinery is required for the preparation of copra.

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FURTHER REPORT ON NIPAH PALM.

By B. J. Eaton and J. H. Dennett.

A Preliminary and interim report on the investigation of Nipah Palm was published in the Malayan Agricultural Journal, Volume XI, No. 3, March 1923.

During the period which has elapsed since the publication of the above report, tapping experiments have been continued. A large number of estimations have been carried out on the sugar content of the juice and an investigation has been made in connection with the disappearance of alcohol from the juice after standing for some days.

The question of the sugar content of the juice is most important to the alcohol manufacturer, who as far as possible requires to standardise his " mash."

Situation of Tapping Area.

The investigations through out the year have been carried out on palms situated at the 15¼ mile Klang-Kuala Selangor Road.*

Description of Area.

Experimental tapping was commenced on palms on this area in February 1923. The palms on the area at the commencement of tapping were far from being under optimum conditions, and had been cut for attap manufacture; while none of the palms were in drains. The land is not flooded except at certain periods during the rainy season and all the palms were situated at some distance from the sea sub-drain.

Observation on yields this year have been less difficult since, although the tapping has not been under the continuous daily supervision of a European Officer of the Department, a large amount of supervision work has been done by Mr. N. Fish of Bukit Ijok Estate to whom thanks in this connection are due.

Construction of Experimental Catch Drains.

About two months after tapping was commenced, a catch drain was dug round a certain group of palms in order to ascertain whether any changes in the yields were produced by such means. The drain was circular and was constructed so that no palm was actually in the drain, the whole group being situated within, and at a distance of two to three feet from it. In order to have all the palms in the group situated at the same distance from the water a diametric cross cut was made.

The results obtained (see Table II) show the marked effect of the drain in increasing the yield of juice.

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* See M.A.J. Volume XI, No. 3, March 1923, p. 51 first paragraph.

Observations on Tapping.

In the previous publication (vide supra) on the investigation it was stated that experiments would be carried out to endeavour to reduce the period of preliminary treatment by tapping the immature flower stalk; the mature fruit stalk was also prepared in a manner similar to that which is used by toddy tappers in tapping the Coconut spathe.

No satisfactory results were however obtained by these methods. On tapping the immature flower stalk a few cubic centimetres of juice were obtained for two or three days, after which the stalk withered. No juice was obtained from stalks treated by toddy tapping methods.

The most striking and important observation on the tapping experiments this year is the fact that the palms have been yielding juice for the whole twelve months of tapping. Such an observation may not appear very important until it is remembered that in all other countries where nipah is indigenous the tapping is seasonal and ranges from four to six months. This confirms the statement of many Malays who have been questioned in regard to this matter.

On the other hand it is still uncertain whether the palms can be tapped continually year after year. It is possible, although from recent observations it does not seem probable, that a palm may be killed by continued tapping. The next two to three years should prove or disprove such an idea.

From the quantitative point of view the yields are of great interest as the summary in Table I will show.

The average numbers of Palms as Distinct from "Stands" in Tapping during any month. Although Variable, is certainly not more than half the number indicated in column 4 of the Table I.

During the months of November and December 1923 and January 1924 it is known that the palms in tapping average not more than one third of the stands indicated.

The figures shew conclusively that a yield of one quarter of a gallon per palm per day, indicated in the previous report, can be maintained over a whole year. Whether these yields can be maintained perennially is still in process of being ascertained.

Records for February 1924, so far as is known at the time of writing, indicate increased yields. The results obtained certainly encourage further work on the problem.

The last column of Table I indicates approximately the percentage of palms (not "stands") which yield not less than $\frac{1}{4}$ gallon per diem. It will be seen that the percentage has risen from 25 at the commencement of tapping to 75 in January 1924.

The gradual increase in yields which is being shewn as tapping proceeds, is probably due largely to the fact that for a period of twelve months no stands have been cut for attap manufacture. Yields and period of tapping of a number of spathes (as distinct from stands or palms) are given in Table II. These yields have not been selected but are taken in order as they occur in the tapping records.

TABLE I.—*Yields for* 1923.

Month.	Days tapping.	Vol. of Juice per month (gallons.)	Mean No. of stands† per month.	Mean per stand† per month (gallons)	Maximum per day for any stand† (gallons.)	Minimum per day for any stand† (gallons.)	Percentage of palm giving not less than ¼ gallon per day.
February ...	12th—28th	14.405	12.6	1.15	0.3	0.006	25
March ...	1st—31st	54.405	21.5	2.06	0.33	0 006	35
April ...	1st—30th	84.250	21.6	3.90	0.38	0.031	45
May* ...	1st—31st	61.000	15.0	4.10	0.43	0.031	35
June ...	1st—30th	34.312	10.4	3.30	0.20	0.031	45
July ...	1st—31st	52.600	20.2	2.60	0.43	0.031	45
August ...	1st—31st	43.330	10.4	3 80	0 37	0.031	50
September ...	1st—30th	68.638	19.0	3.62	0 38	0.031	50
October ...	1st—31st	109 540	27.0	4.00	0.36	0.042	55
November ...	1st —30th	104.200	30.0	3.47	0.36	0.031	60
December ...	1st—31st	114.700	30.0	3.82	0.47	0.031	73
January ...	1st—31st	119.675	24.3	4.10	0.42	0.031	75

* Many stalks finished tapping. New stalks started.

† The word "stand" is used to distinguish from a whole palm. It should be noted that from a single seed three or four "stands" of nipah grow which together constitution one palm.

The formation may be compared to the shape of the ace of clubs, so that if palms are planted at 300 per acre there will be between nine and twelve hundred "stands."

Table II.

Yields of juice from individual spathes in Gallons.

Spathe.	At commencement of tapping. Period of flow (days.)	At commencement of tapping. Yield (gallons.)	At time of writing. Period of flow (days.)	At time of writing. Yield (gallons.)	Remarks on two previous columns.
A	125	28.5	60	9.3	Still flowing.
B	71	10.0	202	45.0	Ceased from 5th January.
C	97	14.1	95	14.8	Still flowing.
D	110	20.4	56	5.5	Ceased December 24th. Greater Yields were obtained on intermediate stalks.
E	124	16.5	130	15.1	Still flowing.
F	72	7.1	92	28.5	Do.
G	66	3.7	117	9.5	Do.
H	32	1.2	96	6.3	Ceased December 30th.
I	165	8.3	155	17.6	Still flowing strongly.
J	44	1.3	158	11.2	Still flowing.
K { 1	Negligible	...	115	8.9	Ceased January 23rd.
K { 2	55	1.7	125	10.0	Still flowing.
L { 1	Negligible	...	167	17.2	Still flowing (2 spathe).
L { 2	92	7.6	92	12.7	Still flowing.
M	94	7.0	152	11.4	Do.
N	40	1.0	103	9.1	Do.
O	46	2.0	48	1.6	Ceased December 29th.
P	47	1.3	126	10.0	Still flowing.
Q	41	1.3	114	15.6	Finished 11th January.
R	85	8.2	15	1.0	Just starting. Maximum in about 6 weeks.
S	81	5.7	93	9.0	Still flowing.
T	45	1.1	90	4.0	Ceased 25th January. Not yet reached maximum.
U	39	1.8	31	1.8	Still flowing.
V	98	7.1	151	17.4	Ceased January 11th.
W	67	2.7	139	42.2	Two spathes part of time.
X	68	3.4	36	4.7	Still flowing strongly.
Y	96	5.7	39	2.7	Almost ceased. Very poor.
Z	58	1.9	103	16.1	Ceased January 11th.

Observations on Table II.

The letter in column I indicates the "stand" concerned.

Columns 2 and 3 given period of flow and yield in gallons of individual spathes after the commencement of tapping in February

1923, while columns 4 and 5 give the period of flow and yields to date of other spathes at present being tapped on the same "stands."

In certain cases the spathe has ceased to yield and another has not yet come into tapping on the same "stand," in which case the date of cessation of flow or tapping in given in column 6. With the exceptions of the spathes on "stand" D which yielded well from the commencement, "stand" Y which has shewn poor yields throughout and "stand" E which has remained constant, a very marked increase in the yields is shewn at the end of the period of twelve months.

With not more than three exceptions latterly each spathe during some period of the flow, has yielded twenty fluid ounces per diem, which based on two stands per palm yielding at any one time an only one spathe per "stand" gives a yield of ¼ gallon of juice per day. (This increases the percentage of palms yielding ¼ gallon of juice per day to 90). This is of interest but should not be allowed to weigh too heavily in the calculation of essential yields.

It will be seen also that the average period of tapping per spathe is between three and four months. It is of interest to note that spathes A.B.C.D.E. & F. were on palms surrounded by catch drains.

Further Chemical Investigations of Juice.

Chemical investigations on the sugar content and rate of deterioration of the juice were carried out during the latter half of the year.

As on previous occasions, for purposes of examining the sugar content, the juice was preserved with alcohol. It was subsequently estimated by means of the saccharimeterand fehlings solution.

The sugar content, the volume of juice (in fluid ounces on the date on which the sugar content was estimated and the product "volume of juice × sugar content," i.e. the yield of sugar in ounces per day, is given in table III.

Table III.

Date.	Spathe No.	Sugar content of juice (per cent.)	Vol. of juice in fluid ozs	Yield of sugar in ozs.
16-7-23	2	17.15	48	8.23
17-7-23	2	17.15	49	8.40
17-7-23	1	15.4	32	4.92
18-7-23	1	15.4	32	4.92
18-7-23	4	18.5	31	5.75
19-7-23	11	26.3	32	8.41
19-7-23	7	19.1	38	7.25
20-7-23	20	22.8	21	4.78
20-7-23	21	22.3	19	4.25

Date.	Spathe No.	Sugar content of juice (per cent.)	Vol. of juice in fluid ozs.	Yield of sugar in ozs.
8-8-23	2	14.2	59	8.36
8-8-23	1	15.0	36	5.40
9-8-23	2	14.0	53	7.42
9-8-23	1	15.6	35	5.46
10-8-23	2	16.2	51	8.26
11-8-23	2	13.9	33	4.59
11-8-23	2	15 3	52	7.95
12-8-23	1	14.1	37	5.21
12-8-23	2	14.0	64	8.95
12-8-23	8	16.0	25	4.00
23-8-23	20	21.2	22	4.66
24-8-23	20	21.8	26	5.66
25-8-23	20	15 9	19	3 02
26-8-23	20	19.1	19	3.62
27-8-23	20	8.0	24	1.92
29-8-23	20	10 2	24	1.92
30-8-23	20	10.2	24	2.44
9-9-23	2	14.3	63	9.00
10-9-23	2	13.0	48	7.25
11-9-23	2	14.6	54	7.88
12-9-23	2	16.1	55	5.85
14-9-23	2	15.3	54	8.25
15-9-23	2	14.7	59	8.67
16-9-23	2	15.4	61	9.12

It is will be seen that there is a great variation in the sugar content of different palms and also variations in the daily content of individual palms.

For palms giving normal yields, the sugar content appears to average five to six ounces per diem except at the commencement and end of tapping, although it should be noted that the results obtained on only seven palms are included in this table.

Calculation of the sugar content of palms included in the previous report also indicated a yield of five to seven ounces daily.

Further Preliminary Investigation on the Keeping Properties of the Preserved Juice.

Investigations on the keeping qualities of the preserved juice were carried out in conjunction with the Plant Physiologist.

Experiment 1.—Three half gallon samples of the semi-fermented juice were collected from the unwashed porous native collecting pots

One of these samples was treated with 20 ccs decinormal sulphuric acid, the second was treated with a small amount of toluene. and the third was used as a control.

Portions from these samples were distilled after four days with the following results:—

TABLE IV.

		Alcohol (per cent.)
Samples treated with sulphuric acid	...	5.45
do toluene	...	4.80
Control	...	7.90

An attempt was also made to estimate the residual sugar by use of the saccharimeter, but this was a failure possibly owing to the fact that the wild yeasts which attack the two hexese sugars, resulting from the inversion of the sucrose, do not react so vigorously with the levulose as with dextrose.

The above results indicate that sulphuric acid might be used to prevent premature fermentation if it is required to manufacture alcohol with specific yeasts, the acid being subsequently removed at the distillery by the addition of the calculated quantity of lime.

An acid is useless if it is desired to manufacture sugar, since the acid, while preventing fermentation, greatly assists inversion with the production of the very undesirable invertose.

Owing to the high alcohol content figure obtained for the control sample above, further samples were collected for investigation of the keeping properties.

Experiment 2.—Three samples of the semi-fermented juice were obtained direct from the collecting pots and portions of these were removed at intervals for the determination of alcohol and residual sugar.

The results obtained are given in table V. The juice was collected on the afternoon of November 4th.

TABLE V.

Date.	Sucrose per cent.	Invert sugar per cent.	Acidity per cent.	Alcohol per cent.	pH Value.
5-11-23	0.8	2.0	0.25	6.4	3.5
6-11-23	0.02	0.10	...	7.3	...
7-11-23	0.02	0.07	0.35	...	3.5
10-11-23	nil	trace	0.516	6.9	...
14-11-23	nil	nil	0.516	6.6	3.5
15-11-23	nil	nil	0.510	6.5	3.5

The results confirm those published previously for a somewhat similar experiment, on juice collected from the spathe in glass vessels. In the above experiment the collection was made in unglazed semi-porous earthernware pots to which the greater inversion and ferment-ation are due.

It will be noted that the pH value, is constant throughout.

The results in the above table also confirm the statement made in the previous publication that conditions here differ very considerably from those in the Philippines.

The bottles in which the juice was contained were not corked, but were left open in order that there should be as little check to fermentation as possible.

Determinations on the fresh juice, taken at the same time as the above samples, showed a sucrose content of between 16 and 19 per cent.

The efficiency of the natural fermentation process therefore, based on the above figures, is about 75 per cent, against 95 to 97 per cent which would be obtained in good commercial practice.

Departmental Sub-Committee.

A departmental sub-committee consisting of the Agricultural Chemist, Agriculturist, (Government Plantations,) and Plant Physiologist was formed some months ago to deal more fully with Nipah Palm.

Work will in future be carried out by a member or members of this committee, according to its nature.

Summary.

Investigations during the year have shown that the yields previously suggested as possible can be obtained and maintained at least over a period of 12 months.

Further it has been shewn, on a small scale, that the yields can be greatly increased by keeping a permanent supply of water round the roots of the palms.

Tapping up to the present has been maintained on about thirty 'stands ".

Results of analysis shew that the sugar content is variable, although an analysis of the contents over the whole area in tapping during 1924 should be sufficient to strike an average.

Sulphuric acid presents possibilities as a control for the alcohol manufacturer, although further experiments are necessary. Up to the present, no suitable substitute for lime has been discovered for the

preservation of juice intended for sugar manufacture. The excessive amount of lime required, except under very sterile conditions, makes it an objectionable preservative.

FUTURE INVESTIGATIONS.

The number of " stands " in tapping will be doubled during 1924 and a survey of the sugar contents of every spathe in the area will be made.

Further planting is in progress, involving different distances and other methods of propagation.

The results obtained by the digging of "catch" drains are so good that most of the area in tapping will be treated in a similar manner.

Further investigation will be carried out this year on methods of preservation of juice.

The Plant Physiologist also contemplates further investigations on the juice during the next twelve months.

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A PRELIMINARY NOTE ON A NEW BARK DISEASE OF HEVEA.

By A. Thompson.

THE renewing bark of rubber trees has been damaged recently by a fungus growth, similar to one which formerly was observed to grow superficially on young bark at the corner of a tapping panel, where it formed a patch of white mycelium from 1—3 inches in diameter. This fungus was never observed to have penetrated the bark and disappeared normally by scaling of the bark.

At the end of 1922 and the beginning of 1923 several specimens of bark attacked by this fungus were received from various parts of the country, and in a few instances it was noticed that slight penetration had occurred.

During the last quarter of 1923 the fungus again became active, and specimens of the attacked bark showed that damage was being done, as in the majority of cases the fungus had penetrated to the wood, and caused the bark to rot.

Symptoms.

One of the first signs of the present attack is a small fan of mycelium $\frac{1}{4}$—$\frac{1}{2}$ an inch above the tapping cut, later forming a small plate of white mycelium, with a mycelial fan at the edges. A number of these plates may be formed, some at the corners and others in the centre, of the tapping cut. Later on some of these plates fuse together into several patches which may be from 6—8 inches in diameter. The disease can be seen from a considerable distance as these patches are conspicuous, being white at the edges where the fan-like mycelium creeps over the bark, and whitish grey in the centre where the bark is rotted.

Trees which were opened up for tapping on January 1st showed the disease after 3 weeks daily tapping. The disease, therefore, can become evident three weeks after infection and possibly sooner.

Little is known as yet about the method of infection, as inoculations of the fungus into the bark of health trees have so far produced no result.

Control.

Up to the present the disease has proved amenable to treatment by putting the affected trees out of tapping and painting them with a 10—15% solution of Agrisol or Brunolinum plantarium, for two applications with 7 days interval between. All the trees in the affected area should be painted with a disinfectant *e.g.* 5% Izal, 10—15% Agrisol, Brunolinum or Brunolinum plantarium. As a precautionary

measure it would be advisable to sterilise the tapping knives of the coolies tapping the affected plots.

The disease is not as yet very serious, as only a few trees are attacked at the same time. The fungus appears to have been educated up to definite parasitism in a comparatively short space of time, and for fear of further developments it should be taken in hand at once.

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THE UTILISATION AND WASTE OF WOOD IN THE PREPARATION AND PACKING OF RAW RUBBER.

By B. J. Eaton.

THIS paper, which deals with the utilisation and waste of wood in the manufacture and packing of raw rubber has been written at the request of the Chief Secretary to Government F.M.S.

Before discussing the problem of the utilisation of wood in the preparation and packing of raw rubber the following extracts may be quoted from a publication on " Wood in the Federated Malay States, Its use, Misuse, and Future Provision " by G. E. S. Cubitt, Conservator of Forests, F.M.S. and S.S., published by the Government in 1920.

I. Waste :—(page 1). During the last twenty years more wood has been wasted in the Federated Malay States than has been used. Waste of such magnitude must always be a matter for regret, but it is a serious evil when combined, as it is here, with a shortage or bad distribution of supplies.

I. (vii) 8. Waste Due to Deliberate (or Unanticipated) Destruction. (d) timber burnt by the planter, (pages 2-3) —Assuming that the area of rubber plantations is one million acres (N. B. It is probably nearer 1¼ million acres, although not all of this was forest when the rubber was first planted, B. J. E.) and that each area held 50 tons of wood, we are confronted with the following facts (*b*) such a stock of wood at the present rates of consumption would have kept the country supplied for about twenty years with all the wood it required.

(*c*) An area of natural forest equal in quality and size to that burnt and similarly situated is sufficient, if properly managed, to supply for ever from one tenth to one fifth (probably more nearly one fifth) of the present demand for wood.

II. 9. Consumption of Wood.—It is estimated that in 1919 the consumption of wood by rubber factories amounted to 219,771 tons in the four States.

II. 10. Item 4. (pages 3-4) These figures are arrived at as follows.—One ton of wood for every 1085 lbs. of 106, tons of rubber exported; rate of consumption calculated from actual results on a rubber output of 5,075,576 lbs. by the Société Internationale de Plantations et de Finance. (Note :—It is not stated whether the whole

output is calculated as smoked sheet, presumably the figures supplied by the S. I. P. E. F. are for fuel consumed in the manufacture of smoked sheet B. J. E.).

III. 13. *Source of Supply (page 6)*.—Rubber planters state that, with proper management, their plantations can be made to supply from thinnings and from naturally dead wood, all the domestic requirements of their labour force for fuel in addition to the timber required for smoking rubber, estimated to amount in all at 2 tons per head of the labour force. It should however be stated that such supplies are by no means always available, and that some planters are already finding difficulty and incurring heavy expenditure in purchasing fuel for their smoke houses.

IV. 26. (page 12). An advance was made in 1917 when, owing to the difficulty of preventing or diminishing the waste of timber on alienated land, the Government agreed.—

(iv) that a condition might be inserted in titles permitting the Forest Department to extract timber from alienated land until the land was required for clearing.

(vi) that Land and Forest officers should be instructed that, if possible, all first class timber should be removed from alienated land before it was burnt.

(vii) that the Resident might, on the recommendation of the Conservator of Forests, prohibit, in particular cases, clearing and burning in excess of the area to be planted up, and might require a scheme of operations to be submitted before clearing was begun.

(ix) that Residents might, in their discretion, charge a premium on land bearing some relation to its forest value.

VII. 32. (page 14). The rubber planter ruthlessly destroys the forest, making little or no use of the timber.

IX. (iii) page 18). The abandonment of rubber smoking and of the use of wooden cases for packing rubber.

49. It is generally admitted that the smoking of rubber is not really necessary and that it is done partly because "Fine Hard Para" from the Amazon is smoked, but chiefly to satisfy the prejudices of the London market. The United States Rubber Company, with an output in Sumatra of 1,000,000 lbs. a month, neither smokes its rubber or packs it in wooden cases, and what this and other companies do, can be done by all, if concerted action is taken. The use of bags for packing rubber would not effect a great saving, as most of the wooden cases now used are imported, but, if the large quantities of

wood (mostly rubber wood) now used for smoking were saved, part of it would no doubt be sold for domestic use and the demand on the forests be correspondingly decreased, probably with a lowering of price. If rubber is smoked, oil which gives good results might perperhaps in some cases be used instead of wood.

(xi) (page 20). Planters to be made responsible for producing fuel for their own requirements.

57. Prominent planters assert that rubber plantations yield enough wood for domestic and factory use on their estates. It should therefore be declared that rubber planters have no claim on adequacy of supplies, either a wood-lot should be reserved on each estate, or quick-growing firewood trees should be planted. In the latter case the advice of the Forest Department would be at the disposal of the planters.

(xii) page 20). *The Prevention of Unnecessary Destruction.*

58. This refers particularly to destruction by the rubber planters, which the present rules are inadequate to prevent. It should be impressed on planters that timber has a value, and it is suggested that this might be done in one or more of the following ways:—

(*a*) the timber should be paid for;

(*b*) the planter should be compelled to extract from the estate and deliver to Government, on terms to be agreed upon, such timber as Government may demand;

(*c*) the grant of land should not convey any absolute right to the timber on the land;

(*d*) a premium should be paid for the timber, recoverable at fixed rates for any timber utilised and not wasted.

There is some difference of opinion as to the extent to which (*b*) is possible. Planters on the one hand complain that, though they offer timber free to anyone who will take it away, few will come forward to do so; timber cutters on the other hand assert that the conditions imposed by planters to prevent damage to the estate render the removal of timber almost impracticable.

Planters say that, when forest is felled and burnt, the greater part of the good timber escapes serious damage and can then be extracted, but timber cutters generally object to work in an open plantation on account of the heat, and complain that charred timber damages their tools and is harder to work than green timber. If these difficulties can be overcome, it should at least be possible to arrange

for the more durable timber to be stored for future use and a useful stock of seasoned material accumulated.

To sum up, the Conservator of Forests issues a strong warning in connection with the present rate of destruction of timber, which is in danger of exhaustion, and urges the vital necessity of providing for the distant future.

Utilisation of Wood in the Preparation and Export of Raw Rubber.

Wood is at present used in connection with the manufacture and export of rubber chiefly for two purposes :—

(*a*) for the manufacture of packing cases for export of all grades of rubber;

(*b*) as a fuel for the drying and smoking of rubber chiefly in the manufacture of smoked sheet.

The greater proportion of the wood used for packing cases is imported into the country, suitably cut and ready for the manufacture of packing cases, while the wood used as fuel for smoke houses is entirely from local sources. In addition a certain amount of wood is used either direct or after conversion to charcoal, as a source of fuel for the prime mover in the factory (Suction gas engines etc.). As is well known, the packing cases at present in use are those known as Momi cases imported from Japan and the well known three-ply Venesta or similar cases, manufactured chiefly in Europe. Tea chests are also used to a small extent. In Singapore, considerable quantities of rubber are packed in boxes, larger than the average sized Momi or Venesta cases, and made from local wood such as meranti. No figures are however available as to the amount of local wood consumed in this way.

Packing Cases.

As far as the writer is aware, no estimate has been prepared or is available as to the amount of wood imported in the form of Momi cases or Venesta cases, but a fair approximation can probably be arrived at on the basis of the amounts of rubber exported annually from Malaya, from the average weight of wood in a packing case and the average weight of rubber contained in such cases.

In former years, Venesta cases were used almost solely on all estates, but during and since the war, a greater number of Momi cases have been used.

The following basis has been used for the calculation of the amount of wood utilised for packing cases :—

Venesta cases (21 ins.)	Weight of wood per case	... 13 lbs.
Momi cases (19 „)	„ „	... 20 „

Amount of smoked sheet packed in Venesta cases	...	220 lbs. (Average)
„ crepe rubber „ „	...	160 „ „
„ smoked sheet „ Momi cases	...	200 „ „
„ crepe rubber „ „	...	150 „ „

(1)	(2)	(3) Number of Venesta cases and weight of wood in cases.				(4) Number of Momi cases and weight of wood in cases.			
		Smoked Sheet.		Crepe.		Smoked Sheet.		Crepe.	
Year.	Export of Rubber from Malaya. (Tons.)	Number.	Weight of wood (Tons.)	Number.	Weight of wood (Tons.)	Number.	Weight of wood (Tons.)	Number.	Weight of wood (Tons.)
1906	400	4,000	20	5,600	30	4,400	40	6,000	50
1907	1,000	10,000	60	14,000	80	11,000	100	15,000	130
1908	1,500	15,000	90	21,000	120	16,500	150	22,500	200
1909	3,000	30,000	180	42,000	240	33,000	300	42,000	400
1910	7,000	70,000	420	98,000	560	77,000	700	105,000	930
1911	11,200	112,000	670	156,800	900	123,200	1,120	168,000	1,490
1912	19,200	192,000	1,150	268,800	1,540	211,200	1,920	288,000	2,560
1913	29,500	295,000	1,770	403,000	2,360	324,500	2,950	442,500	3,930
1914	43,200	432,000	2,590	604,800	3,460	475,200	4,320	648,000	5,760
1915	68,500	685,000	4,110	959,000	5,480	753,500	6,850	1,027,500	9,130
1916	96,800	968,000	5,810	1,335,200	7,740	1,064,800	9,680	1,452,000	12,910
1917	127,000	1,270,000	7,620	1,778,000	10,160	1,397,000	12,700	1,905,000	16,930
1918	130,200	1,302,000	7,810	1,822,800	10,420	1,432,200	13,020	1,953,000	17,360
1919	165,400	1,654,000	9,920	2,355,600	13,230	1,819,400	16,540	2,481,000	22,050
1920	162,000	1,620,000	9,720	2,268,000	12,960	1,782,000	16,200	2,[illegible]30,000	21,600
1921	151,000	1,510,000	9,060	2,114,000	12,080	1,661,000	15,100	2,265,000	20,130
1922	212,700	2,127,000	12,760	2,977,800	17,020	2,339,700	21,270	3,190,500	28,360

In the above table, the number of cases and amount of wood used for packing cases has been calculated on the assumption in column (3) that Venesta cases only are used and in column (4) that Momi cases only are used. The weight of wood is possibly not of great importance, but the large saving in cost by using cases other than wood, can be easily determined by the figures of cost given later.

No information is available as to the proportion of smoked sheet to crepe which is exported. Another factor, which affects the figures although not to any marked extent, is the amount of blanket or thick crepe, which is manufactured on some estates from lower grade rubbers, (such as tree scrap, bark scrap and earth scrap rubber of mixtures of these, known as compo grades) and also manufactured to a fair extent from native sheet in the large crepeing factories in Singapore. Blanket or thick crepe occupies a smaller space per unit weight of rubber than thin crepe and is very similar in bulk to sheet in respect of packing space required. One other factor which has also reduced the number of packing cases used during and since the war, is the practice of using small presses in the estate factory, in order to compress more rubber into the cases.

Local wood, used in the manufacture of packing cases in Singapore for export of rubber, is included in the above estimate. These packing cases are usually constructed of thicker and heavier wood, but this is compensated to some extent by the larger size of the cases.

It may be remarked here that these cases are used chiefly for packing rubber, which is received in Singapore from the Peninsula, packed in canvas bags or bales made from locally manufactured or imported menkuang or grass matting A portion of the native sheet, which is creped in Singapore factories, is also packed in boxes made locally from lo a' wood. This includes a lot of crude rubber imported from Sumatra and milled and repacked for export in Singapore. Although canvas bags and matting bales are used for local transport purposes in shipping rubber to Singapore, little or no rubber has been exported outside Malaya in such packing until recently. The packing of rubber for export in bales made of good lower grade rubber has also been adopted up to the present only in the case of experimental shipments.

SUBSTITUTION OF NON-WOOD PACKING.

The primary objection to baling rubber in casings composed of soft materials is that the rubber becomes "massed" so that it is difficult to separate individual sheets or pieces of crepe, when the bales are opened.

This "massing" of the rubber is due almost entirely to the fact that when the rubber is shipped, the lower bales in the hold must of necessity be compressed by the bales above. In the case of wooden packages, this does not occur to the same extent, since the rubber in each box is not affected by the weight of other boxes, owing to the rigidity of the cases.

Smoked sheet packed in cases under pressure must however arrive home in a similar massed condition.

In the case of non-waterproof packing materials, e.g. matting, canvas, lower grade crepe rubber (which may be slightly porous, owing to the rubber not being satisfactorily machined to eliminate small pin holes) jute sacking or other materials, there would be also greater probability of the wetting of such rubber by transport during wet weather. Provided however that the bales were not allowed to lie in the open, this could be avoided by the use of some covering, during local transport in bullock carts, motor lorry or other means of conveyance. This disadvantage also applies to a lesser extent to rubber packed in wooden cases, which frequently become wet after leaving the estate, causing the development of moulds and spot disease in the rubber. It need scarcely be mentioned also that rubber should not be packed in materials such as untreated jute sacking in direct contact with the rubber, since it is more difficult to remove the fibres of such packing from the rubber subsequently than to remove chips of wood or sawdust derived from broken boxes.

(*Note*:—Specially treated jute sacking is however being used at the present time for baling rubber, exported to America).

The use of a lower grade rubber packing inside ordinary sacking would however prevent contamination of the contained rubber. One advantage of the raw rubber packing is that the packing material itself can be used in the manufactory after subsequent washing etc. so that the only "waste" would be the baling wire or cord.

It should not be necessary to emphasise that the massing of the rubber, which occurs by baling in non-rigid packings, does not in any way deteriorate the rubber, and that objections raised on this score are, in the writer's opinion, not worth consideration. In fact the writer is prepared to state that such rubber is probably preferable from a storage point of view, since the deterioration which usually occurs in raw rubber is due largely to surface effects and in a block or mass of rubber the surface per unit weight is reduced.

Types or Grades of Rubber in relation to packing.—The type of packing case may also be considered in relation to the type of rubber prepared. Types of rubber which are suitable particularly to non-rigid packing cases are "block" rubber and "slab" rubber. In the case of these types of rubber the question of "massing" is not involved.

Block rubber consists of thin crepe dried in vacuum or hot air driers and subsequently pressed in hydraulic presses. Slab rubber can be creped and prepared in this way and is of excellent quality.

Slab rubber prepared on a large scale on the H. A. P. M. (Holland-American Rubber Company) estates in Sumatra and shipped in the slab form has been exported several years to America in treated jute sacking.

In concluding this section on the use of materials, other than wood, for packing cases, the following details are of interest in respect of (a) lower grade rubber packing similar to the Gjorup packing case, (b) Malayan Menkuang matting, for which a bale has been designed and patented, (c) tobacco bale matting (this matting is also used by at least one other estate for local transport to Singapore), (d) jute sacking, (e) canvas bales.

Rubber Packing.—Provided the rubber used for packing is well knitted together on the machine to render it impermeable to dust and small particles, crepe rubber (a good lower grade) is quite suitable as a packing material.

Special cases of this material have been designed and patented by Gjorup Bros. in Malaya in 1921.

It is not a difficult matter for planters to make their own cases from lower grade crepes.

In the case of this material the rubber constituting the casing can, after washing, be used by the manufacturer for second quality articles.

In a pamphlet on the subject the "inventors" shew that the cases can be made from about 10 – 12 lbs. of lower grade crepe rubber. The percentage of suitable lower grade to "first latex" rubber made on estates is sufficient to provide the amount required on any estate for packing purposes. Such cases measuring 19 × 19 × 24 inches will contain about 225 lbs. smoked sheet rubber or 75 lbs. of thin crepe compared with 200 lbs. and 150 lbs. respectively for a Momi case; the cost of the packing is considerably less, even if the rubber used for the cases is assumed to have no value. The reduction in cost amounts to from $20/- to $35/- per shipping ton.

(b) and (c). Menkuang palm or similar matting used for the baling of tobacco in the Netherlands East Indies is eminently suitable as a packing material for rubber. A packing case of this material has been designed and patented in Malaya. These cases cost about half the price of locally made Momi cases and one third that of imported Momi cases

Cases can also be made by planters in the estate factory. Experiments have also been carried out in Java by planters and by the Rubber Proefstation at Buitenzorg, Java on the packing and export of rubber in bales made of matting of this type, which is also used for the baling and export of tobacco.

Many local rubber dealers in Malaya also bale their rubber in similar matting, which is imported in sheets from China. This material is probably one of the best and cheapest for baling of rubber for export to Europe and America.

(d) *Jute or Gunny bag packing.*—Jute or gunny sacking is not very suitable as a packing material, unless previously treated on one side, to prevent the loose fibres from adhering to the rubber.

Slab rubber and Hopkinson Sprayed rubber is however exported from Sumatra in jute sacking after suitable treatment of the sacking.

One of the largest manufacturing firms in America, which buys large quantities of rubber in Singapore, also exports all its rubber from Singapore in jute sacking (old rice bags) which are coated on one side with a preparation of starch and glue and dusted with talc to prevent adhesion of the fibre to the rubber contents of the bales.

The fact that two of the largest rubber manufacturers in America have adopted this packing for rubber exported from Malaya and Sumatra should be sufficient to indicate that the packing is suitable. The cost of the packing material, including the sewing of the bales is less than half the cost of wooden cases.

"First Latex" crepe rubber is also transported to Singapore by the Kajang Central Rubber Factory (a co-operative factory) in gunny bags. The bale of crepe is first wrapped with 4 lbs. of crepe of the same grade. One broker sells the contents, including the crepe wrapping, while another deducts 6 cts. per lb. for the crepe used as wrapping. The time taken to pack rubber in wooden cases and in bags is stated to be the same and therefore the cost in both cases is the same.

Mr. Hands the manager of the factory has kindly supplied the following figures :—

Pre War.	Wt. in lbs.	Rubber content (lbs.)		Cost of Case.	Total Cost.
		No. I crepe.	Lower grade crepe.		
Venesta Cases ...	13	165	170	$1.37	1.40½
Momi case ...	20	150	140	0.56	0.66
PRESENT DAY.					
Venesta Case ...	13	165	170	1.65	1.70
Momi case (secondhand)	20	150	140	0.85	1.01
Momi case (new) ...	20	150	140	1.11	1.28
Tea case ...	20	140	140	1.25	1.37
Jelutong case ...	19½	140	140	0.82	1.00½
Gunny bags ..	3	150	140	0.15	0.15½

In each case the size of the cases is 24 × 19 × 19 inches and the contents 5 cubic feet. The difference between the cost of cases and total costs includes "making up" in the case of the Venestas, strapping, nails and "making up" in the case of the Momis and additional wire and staples in the case of the secondhand Momis and other wooden cases.

The additional cost in the case of the gunny sacks is only a ½ cent for string.

(*e*) *Canvas Bales.*--Canvas bales have been designed and patented by a Japanese firm in Malaya and are used by some estates in Malaya for local transport to Singapore. The empty bags are returned to the estate and used many times The initial cost is high but the packing is economical for local transport, in view of the fact that the cases are used many times

This method of packing may not be suitable for export outside Malaya as the empty bales will probably not fetch much if sold and the cost and trouble of returning them will probably be too great.

THE USE OF WOOD AS FUEL IN THE PREPARATION OF RUBBER.

Almost all the wood used on estates in the preparation of rubber is consumed in the smoking process for the manufacture of smoked sheet.

The use of wood as fuel in the preparation of rubber may be considered from the following points of view :—

(*a*) Intrinsic quality of the rubber.

(*b*) Producer's point of view.

(*c*) Market or buyer's point of view.

(*d*) Manufacturer's requirements.

(*e*) Elimination of fuel in the preparation of rubber.

(*f*) Substitution of fuels other than wood.

(*g*) Preparation of other types of raw rubber.

It will be evident that, in any discussion of these various view points, there must inevitably be a certain amount of overlapping.

The only point of view which should really require discussion is the intrinsic quality of the rubber, which should represent the manufacturers requirements.

ORIGIN OF SMOKING PROCESS FOR PLANTATION RUBBER.

Before discussing the problem under the various headings indicated above, it is probably desirable, even at this stage of the plantation industry, to refer to the origin of the smoking process as employed for the preparation of smoked sheet, and the reason for its retention.

Although the writer has no definite information as to (*a*) whether the smoking of plantation rubber was commenced first in Ceylon or Malaya (*b*) the originator of smoked sheet (*c*) the approximate date on which smoked sheet was first placed on the market, (it does not appear worth while at the moment to search for this information) it was commenced very early in the history of the plantation rubber industry. It is practically certain however, from the literature on the subject and the opinions expressed, that smoking of plantation rubber was first practised as an imitation of the Amazonian process of smoking, used in the preparation of the highest grade of wild rubber viz. Fine Hard Para. In the early days of the plantation industry, there was, as in any new form of preparation, a prejudice in favour of this grade (Fine Hard Para) which was well known to the manufacturer in respect of its constancy and other qualities during vulcanisation.

This prejudice still exists, although only to a small extent at the present time, and the premier grade of wild rubber still realises a higher price than the highest grade of the plantation product after the moisture content and loss on washing are taken into account. In at least one manufactory in England in 1920 visited by the writer, only Fine Hard Para was still being used, while in others it is still said to be used exclusively for certain classes of goods.

In the early days of the industry also, it was considered that the South American smoking process conferred special qualities on the rubber, in virtue of the type of fuel used, which was assumed to be chiefly the fruits or nuts of the palm, Attalea Excelsa. The plantation method, in which sheet rubber was prepared by coagulation in the usual way with acetic acid and subsequently smoked, as in present practice, was considered also, in the early days, to have failed as a successful imitation of the South American process, as the smoke was supposed to be absorbed superficially only.

Various machines were designed and patented for preparing rubber on a principle similar to that used for the preparation of Fine Hard Para but constructed on a scale suitable for dealing with the large quantities of latex collected daily on estates. Hitherto however none of these have been adopted. Even as recently as 1921, Sir Henry Wickham, the "father" of the plantation rubber industry, has patented a new machine (which is stated to be an improvement on his former machine) for preparing rubber by the South American process. While there may have been accidentally or incidentally some special merit in the process, due either to the method or the fuel it should be fairly obvious that the method was adopted in the earliest days by the seringeiros (native collectors and tappers of South America) because it happened to offer a convenient method of preparation suitable to forest or jungle conditions and within the capabilities of the native collectors and not on account of any intrinsic value as a process.

While the writer and other research workers are probably still prepared to admit the superiority of Fine Hard Para in one or possibly more than one respect, this superiority has no connection with the smoking process nor with the fuel employed.

For reasons similar to those for which the native collectors adopted and retained their process for the preparation of Fine Hard Para, estate managers and owners have retained the smoking of plantation rubber viz. on account of its convenience in certain directions.

Thus the smoking of plantation sheet, adopted in the first instance as an imitation of the method of preparing Fine Hard Para, on account of the fact that it was thought to confer superior qualities on the rubber, has been retained mainly for other reasons and it is in this connection that arguments against its continuation will have to be chiefly directed.

Effect on the Intrinsic Quality of Rubber.

The researches of the writer and other workers have shown that the smoking of rubber, as practised on estates, confers no special or superior qualities on rubber. In fact, as far as quality, judged on rate of vulcanisation, is concerned, the effect of the smoking may be described as detrimental, although in the smoking process, as the writer has shown, two factors are concerned viz. heat and smoke. The effect of the former, within the normal limits of smoke house conditions is to accelerate the rate of vulcanisation of the rubber, without effecting its physical properties.

The effect of the normal process of smoking therefore results from a balance of two factors operating in opposite directions and, for commercial purposes or as far as the value of the rubber to the manufacture is concerned, smoked sheet is probably in most cases neither superior nor inferior to unsmoked sheet. From the point of view of quality therefore the smoking process in the case of sheet could be abandoned.

Formerly thin crepe was smoked to some extent, but chiefly before the introduction of sodium bisulphite, which resulted in the pale crepe at present marketed as one of the first grades of plantation rubber.

Smoked crepe however is no longer prepared ; one reason for its abandonment was probably the fact that many defects of appearance in crepe rubber can be obscured easily by smoking and the buyer therefore was unable to distinguish between different grades. The writer has shown that smoking has little or no effect on crepe rubber.

The reasons for the retention of the smoking process in the case of sheet do not exist in the case of thin crepe, so that the smoking of crepe rubber, which has already been abandoned, need not be considered further.

In the case of "slab" rubber the writer has shown that a marked reduction in the rate of cure occurs, while no superior qualities are conferred on this type of rubber, by smoke-drying. Smoking therefore is not essential, in fact it should be avoided, in the preparation of this type of rubber.

It can therefore be concluded that, in the preparation of all grades of rubber, smoking is not advantageous as far as the intrinsic quality of the rubber is concerned.

Producer's Point of View.

The type of rubber prepared by the producer or grower must be considered from the point of view (*a*) Economy in preparation, (*b*) Selling value as judged by the buyers or brokers (*c*) Manufacturers' requirements, which should be high intrinsic quality, irrespective of appearance.

It has already been indicated that, although smoked sheet was prepared first as an imitation of the Amazonian process for the preparation of Fine Hard Para, it was soon found to have advantages over air-dried sheet in respect of rapidity of drying and comparative freedom from moulds and bacteria. The antiseptic properties of the smoke prevent mould growth to a considerable extent, while considerable saving in drying space and time of drying is effected, in comparison with the preparation of air-dried sheet.

By the use of suitable antiseptics however and drying in hot-air drying rooms by means of special stoves, resulting in economy of fuel, a good imitation smoked sheet can be prepared. On a new estate for many years, plenty of wood is available from the jungle, which has been felled for planting purposes and which must be cleared in order to reduce or eliminate diseases, or from the thinning out of too closely-planted rubber trees, so that, in such cases, the cost of fuel for smoking has been negligible. Further in the preparation of sheet rubber the cost of equipping a factory is considerably less than for the preparation of crepe rubber, since small power or hand machines can be used for rolling the coagulum.

On the other hand the manufacture of "first latex" pale crepe, from latex to which sodium bisulphite has been added to produce a pale rubber, is more fool proof than the manufacture of smoked sheet, as long as rubber is sold largely on appearance. Smoked sheet develops certain defects, which, while they have no affect on the intrinsic quality of the rubber, affect its market value as judged by the buyers.

As long as fuel is available therefore on the estate, the cost of manufacture of smoked sheet should be less than the cost of preparation of pale crepe. If and when fuel for smoking has to be purchased, the preparation of thin pale crepe will probably be more economical.

The writer and others have shown that, except for special purposes, sheet rubber is generally superior in quality to thin crepe and would be used by manufacturers for all purposes when colour of the finished article is not the chief desideratum.

Thus smoked or unsmoked sheet rubber or some other type of preparation is to be preferred from the manufacturer's point of view to thin pale crepe, which is normally air-dried and requires no fuel, except for power purposes during machining.

As far as the producer is concerned therefore, unless the industry in the principal producing countries become so organised that all producers can be persuaded or compelled to prepare rubber of a particular type, it is doubtful whether anything less than high cost of wood will effect any alteration in the type of rubber produced.

Any Government restriction on the method of manufacture in a particular country would probably be detrimental to the country concerned.

It is hoped to indicate however that economies can be effected by the producer and that one or more new types of rubber can be substituted for smoked sheet with advantage to the manufacturer in respect of quality.

Market or Buyer's Point of View.

The present methods of buying and selling raw rubber may be described as almost entirely artificial, being based mainly on appearance and having no real relationship to intrinsic quality. This is due principally to the rapid rate of growth of the plantation rubber industry, with which scientific research on the raw product was unable at first to keep pace. At the present time however our knowledge of the qualities of the raw material and the causes of real or intrinsic defects is more advanced and we know that, to a considerable extent, appearance, as a criterion of quality, is misleading, although generally a good appearance indicates careful preparation and supervision in the estate factory.

The market for smoked sheet however is well established and the effect of removing this grade from the market, except by action by the whole of the plantation industry requires careful consideration.

Restriction in the manufacture of smoked sheet must be brought about by forcing on the producer a realisation of the necessity for saving fuel and on the market the fact that other types of rubber equal or superior to smoked sheet can be manufactured. If the industry were well organised especially at a time, such as the present, economies in production could be effected by forcing on the market another type of rubber and such action is justifiable, provided the substituted product can be shown to be equivalent or superior in quality.

If the plantation industry were organised the buyer need receive little or no consideration.

Manufacturers' Requirements.

It may be safely assumed that the manufacturer is concerned primarily with the cost of the raw rubber and its intrinsic quality. Only for special purposes is the colour and appearance of the raw rubber of primary importance and the demand for such purposes is met by the preparation of thin pale crepe, which requires normally no consumption of fuel for drying, while for power purposes, oil fuel, charcoal or coal can be employed.

It has already been stated that in the case of the large estates belonging to the United States Rubber Coy. in Sumatra, a particular type of rubber, which at present cannot be sold on the open market, is prepared and shipped to the factories of this company in America. The Company using the raw rubber has doubtless recognised its value and is not concerned with appearance.

Another large Company in Italy is also using "slab" rubber, prepared on its own estates in Malaya.

The preparation of smoked sheet is therefore not essential to the manufacturer. If it were possible therefore to establish direct buying and selling between rubber manufacturers and producers of raw rubber, type of rubber other than smoked sheet could be marketed.

Elimination of Fuel in the Preparation of Raw Rubber.

It is doubtful whether the elimination of fuel entirely in the preparation of raw rubber is advisable. The only satisfactory method would be the preparation of thin pale crepe, which does not require artificial drying, or the conversion of such thin crepe, after natural drying, into a blanket or thick crepe.

In view of the generally somewhat inferior quality of thin pale crepe and its slower rate of vulcanisation, the writer is of opinion that the preparation of this grade only (either as thin crepe or as blanket crepe, after drying in the form of thin crepe) is not advisable.

The preparation of a thick blanket crepe direct from latex will be discussed later. In the preparation of certain types of rubber however, fuels other than wood can be employed.

Substitution of Fuels Other than Wood.

In the preparation of smoked sheet the elimination of wood fuel is not possible, since other fuels e.g. oil, coal or charcoal will not produce a similar product. Other waste materials such as lalang or other grass, blukar (secondary jungle) or other vegetable or cellulose material is not available in sufficient quality and would also not produce a product similar to smoked sheet prepared by the burning of wood.

An equally good imitation smoked sheet could however be prepared by "doping" latex or freshly machined sheet with creosote products and then subsequently drying the sheet in hot air chambers or warm rooms in which various kinds of fuels other than wood could be burnt in special furnaces or ovens, so that only the heat from the combustion of such fuels acts on the rubber, the products of combustion of the fuel being led outside the heating chamber.

With properly constructed drying rooms and furnaces this would undoubtedly result in economy of fuel.

It has also been shown by the researches carried out at the Department of Agriculture that unsmoked sheet is equal in quality to

smoked sheet and in some respects may be superior, especially when dried at a slightly elevated temperature.

Unfortunately unsmoked sheet, unless dried at an elevated temperature, is very liable to attack during drying by "spot" disease caused by fungi and bacteria; experiments are still required to ascertain whether unsmoked sheet dried artificially will develop "spot" disease more rapidly than smoked sheet.

Unless antiseptics are added to the latex this would probably occur. If thick blanket crepe were prepared direct from latex this could be dried by heat derived from fuels other than wood and would be an excellent substitute for smoked sheet. Coal or oil and various waste products in certain districts could be used as fuel in special furnaces.

In addition, if acetic acid and various other products obtained by wood distillation were manufactured locally, the resultant charcoal could also be used as fuel in special furnaces in the drying rooms.

PREPARATION OF OTHER TYPES OF RUBBER.

Thin Pale Crepe.—It has already been indicated that thin pale crepe rubber is of value to the manufacturer for special purposes and that, although this type of rubber can be prepared without the use of fuel, its preparation as the sole grade of "first latex" rubber is not desirable, since its somewhat inferior quality and slower curing properties are disadvantageous.

(*Note.*—No investigations have yet been published on the affect of the addition of accelerators on the quality of this grade of rubber. In view of the increasing use of artificial accelerators, and provided their addition to this grade of rubber increases the tensile strength of the rubber to render it equivalent to other grades similarly treated, the preparation of thin pale crepe could be recommended as the sole first grade rubber).

At the present stage of our knowledge however, the manufacture of thin pale crepe, as the only first grade product, cannot be recommended.

Blanket Crepe.—Blanket crepe prepared from dried thin pale crepe is similar in quality to thin pale crepe, although owing to the smaller surface area per unit weight of rubber, it is better from the point of view of packing and subsequent storage. Its preparation also requires extra machinery.

Block rubber made from thin crepe is superior in respect of packing space, transport and surface area per unit weight, but extra time and machinery are necessary for its manufacture, while its quality is similar to that of thin crepe.

Blanket crepe made direct from latex, by being subjected to less machining and dried in hot-air chambers or artifically heated drying rooms should prove an excellent substitute for smoked sheet. This type

of rubber can be dried artificially by the use of any type of fuel, provided the products of combustion of the fuel are not allowed to come into contact with the rubber. Special artificial drying rooms could be used which would also result in economy of fuel.

Slab Rubber.—The type of rubber, which was originated by the Department of Agriculture, is an excellent grade to substitute for smoked sheet and its use would probably be more general if raw rubber were not bought and sold on the market chiefly by appearance.

Although this type of rubber can be prepared without the aid of fuel or artificial drying, it is preferable in some respects to mature and partially dry it at an elevated temperature.

Our experiments have shown that the drying period, especially at a temperature equivalent to that normally employed in smoke houses, viz. about 120° Fah., need not exceed six days in the case of large slabs and this represents a considerable economy compared with the normal period of drying for smoked sheet. Further, any type of fuel to produce the necessary heat, may be used, since it is preferable that the products of combustion should not come into contact with the rubber.

When shipped in the form of "slab" this type of rubber contains from 10 to 20 per cent of moisture according to the method of preparation and drying and has to be converted into crepe by the manufacturer before it can be dried completely for vulcanisation purposes.

As has been stated previously, this type of rubber has been prepared and shipped by the H. A. P. M. in Sumatra for several years. The coagulum is machined roughly and is then kiln-dried to produce a dry outer skin and shipped in 200 lbs. bales enclosed in specially treated jute sacking. The rubber, which contains about 12 per cent of moisture, is sent to the Company's own factories in America and not sold on the open market.

It is stated that "it would not be possible to sell this rubber on the open market, since, apart from other considerations, few manufacturers have sufficient facilities for washing and ultimate drying "and that" it is doubtful whether the process shows any economy of fuel consumption, as wood is used as fuel both for power purposes and for working the kilns."

The preparation of this type of rubber on a large scale by a Company in Malaya has shown that it can be "matured" in a much shorter time than is required for the complete drying of smoked sheet, under similar conditions. Owing to the fact that a latex of high concentration can be used, slabs can be prepared from a gallon of latex containing 2.5 to 3 lbs. of dry rubber, which effect an economy in space in the drying house.

This type of rubber is also prepared on estates in Malaya belonging to another rubber manufacturing Company and shipped to the manufactory in Italy.

Economy in freight is also effected since, owing to the high rubber content of the slabs, a larger amount of rubber can be packed in unit space, in spite of the moisture content.

The type of rubber has also been prepared and, after maturation, creped on a large scale by a company in Malaya, the crepe being subsequently air-dried in an ordinary crepe drying house.

In spite of the greater power required to machine the hard matured coagulum, the writer is informed that the cost of crepeing is considerably less than the cost of making "first latex" pale crepe since there is no necessity to "finish" the rubber to the same extent and less crepeing is required, so that much more rubber can be machined in the same time.

As previously indicated, this type of rubber can also be converted into thin crepe and be subsequently hot air or vacuum dried and blocked for export.

The preparation of this rubber would result in considerable economy in estate factories and in the cost of packing, transport and fuel.

Whole Rubber.—Comparatively recently, apparatus has been patented for the desiccation of latex by spraying (impinging) latex in the form of a jet on a rapidly rotating disc in a hot-air chamber. Oil fuel is used in the furnaces for heating the chambers. The process is known as Hopkinson's or the Spray process and has been patented by the General Rubber Company, U.S A.

It is not necessary to describe in detail in this paper, the method of procedure, but it might be stated that several plants are at work on the Company's plantations in Sumatra and arrangements will probably be made to introduce the process into Malaya.

It has been known for some years that rubber prepared by the evaporation of latex has excellent tensile qualities and a comparatively rapid rate of vulcanisation but no apparatus has been available until recently for the satisfactory preparation of such a type of rubber on a large scale. In the manufacture of this type of rubber about 60 to 65 per cent. of water has to be evaporated from latex and no figures are available as to the economics of the process in respect of the fuel required for the evaporation of this water. The process however lends itself to high efficiency in respect of fuel economy. Fuel other than wood can also be used as a source of heat. In Sumatra, oil fuel is burnt in special stoves or furnaces. This rubber, like slab rubber, can also, after being pressed into blocks, be shipped in bales of non-rigid packing material such as treated jute sacking, as is done at present in Sumatra.

Summary.

Packing Cases.—Non-rigid casing material can be used for the baling or packing of rubber, in lieu of wood, without affecting the

quality of the rubber, such as canvas, matting made from local raw materials, jute sacking suitably lined or treated in order to protect the rubber from the fibre of the jute and lower grade crepe rubber used alone or as a lining to other packing. Such packing material is especially suitable for slab rubber or blocked "whole" rubber prepared by the desiccation of latex.

The export of rubber from Malaya and Sumatra in bales of treated jute sacking by two of the largest rubber manufacturing firms in America and trials in Malaya and Java with tobacco matting bales or similar material indicate that these materials can be substituted for wood cases with satisfactory results and at considerably less cost to the producer.

An organised rubber industry, in view of the necessity for lower costs of production, should insist on such packing, irrespective of the foibles of the buyer.

Fuel for Drying and Smoking Rubber.- The substitution of fuels other than wood, such as coal, oil or charcoal can be made, if certain types of rubber are manufactured e.g. Slab rubber, whole, rubber, blanket crepe or "smoked sheet," sheet made by treating unsmoked sheet or latex with creosote etc., and subsequent drying in hot air. Economy in the use of wood or other fuel can also be effected in such cases by the use of special furnaces if wood is available and is found to be cheaper than other fuels.

Elimination of fuel for drying rubber can also be effected by the manufacture of thin crepe or the subsequent conversion of dry thin crepe into blanket crepe. This however may not be desirable on account of the poorer quality of thin crepe compared with sheet and other types of rubber.

Slab rubber can also be cut into thin slices and dried in hot air driers and then pressed into blocks or, after the maturation period, it can be converted into ordinary crepe and air-dried at normal temperature. Large consignments of "slab" crepe have been made and sent to America by a group of estates in Malaya.

Conclusion.

The question of the baling of rubber for export is a matter which could probably be dealt with most effectively by an organisation such as the Rubber Growers' Association, which controls the largest production of plantation rubber, apart from small holdings. The small holders do not affect the situation, since they sell their product chiefly to local dealers and most of this rubber is already packed in non-wooden cases. The rubber manufacturer would not be affected adversely and the market buyers need not be considered.

Such a change in packing cases would save the producers large sums annually, but the change can only be effected by some fairly powerful organisation.

(*Note* :—The saving effected by the substitution of gunny bags for Venesta and Momi cases as used in the Central Factory, Kajang, can be easily calculated from the table giving the rubber exports from Malaya from 1906-1922 and from the figures quoted for relative costs at the Central Factory, Kajang.)

With regard to the preparation of other types of rubber, in order to eliminate the use of wood fuel or to reduce the present wastage, this also appears to be a problem to be taken up by a powerful organisation.

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COLOMBIAN PITA FIBRE.

By B. Bunting.

IN 1919, an undertaking called the Arghan Company, Ltd., was formed with the object of organising an expedition to investigate and obtain supplies of a fibre plant for cultivation in the East. The plants were introduced into this country under the name of "Arghan," called after the company. It has not been found possible to determine the botanical name of these plants, and this cannot be done with certainty until the plants reach the flowering stage.

At a later date, another Syndicate, known as Pitales, Ltd., commenced to distribute Colombian Pita fibre plants in this country, thought to be a similar plant to that introduced by the Arghan Company.

A considerable amount of interest has been taken in these recent introductions. The last named plant occurs wild in the tropical parts of South America and is known by the vernacular name of "Pita." The term Pita is a Spanish word applied generally to various fibre-yielding plants and also to the fibres obtained from them. The botanical identity of the plant remained obscure for some considerable time and was thought to be *Ananas macrodontes*, E. Morr., but recent investigations have shown that the plant in question is *Bromelia Magdalenae*, C. H. Wright.*

A full description of the Colombian pita fibre plant has been given by Mr. M. T. Dawe, F.L.S., in "Tropical Life," December 1920 and January 1921, and the information contained in the above articles has been utilised extensively in compiling this paper.

Description of Plant.

The Colombian Pita plant resembles the pineapple, in fact, it might be described appropriately as a giant pineapple plant. A single mature plant carries from 20 to 40 leaves, which attain a length of 10 feet or more, and are about 1 inches broad in the centre. They are convolute towards the base, otherwise flat, and taper towards the apex. The margins are toothed; from the middle to the base the teeth turn downwards, in the upper half upwards.

The flowers are produced in pineapple-like heads, which are borne singly, sometimes, however, in groups of two or three. The heads are about 9 inches long and 4½ inches broad, but differ from the ordinary pineapple inflorescences in having conspicuous rose-coloured bracts. The flowers are blue and fugitive.

Fruiting is irregular, but since the plant throws out stolons underground, giving rise to suckers, the latter can be used for propagation. So strong is its reproduction by this method and the growth of

* Kew Bulletin No. 7, 1923 p. 267.

the plant so vigorous, that it takes entire possession of the land to the exclusion of other forms of undergrowth, excepting trees and palms which afford the shade necessary for its growth. It therefore forms impenetrable masses covering extensive areas, which resemble plantations to such an extent that the Colombians call them "pitales."

Occurrence of Pitales.

Pita is a shade loving plant and is usually found as undergrowth in the shade of the tropical forests. The Chiriguana forest, a mixture of trees and palms, is famed throughout Colombia for its extensive "pitales." The density, in which the pita plant grows to the exclusion of all other plants, may be indicated by the fact that it is impossible to penetrate these forests except by hacking a way through by a machete or cutlass (parang). The plant flourishes in light sandy soil; it will not grow on wet land or land subject to frequent inundation. Pita lands are therefore generally healthy and the forests are usually well-watered by clear flowing streams from the Cordilleras. The plant will not thrive in the open in the tropical regions, and where the plant has been observed in the open it has been, in every case, in the sub-tropical parts of the country.

Cultivation of Pita.

As far as is known, the Colombian Pita plant has not been cultivated on a commercial scale, even in its native habitat, and the following recommendations are based on the results of preliminary investigations made with a small number of suckers received by this Department from the Royal Botanic Gardens, Kew. These young plants are being cultivated under conditions similar to those under which the plant flourishes in its native country.

Young plants or suckers, which have been exposed to a long sea-voyage, should be planted as soon as possible about 18 inches apart in specially prepared, raised, nursery beds, consisting of soil having a fair proportion of sand and humus. The beds must be shaded with attaps, placed from 4 to 5 feet above the ground.

It is important to see that the soil around each plant is well pressed down, otherwise the plants may wither. They should be watered when necessary and remain in the nursery beds until established.

When large quantities of the suckers are being planted it is convenient to have the nursery beds about 100 feet long and 5 feet wide, giving three rows of plants in the bed.

Later, when local planting material is available, nurseries may be unnecessary, since the suckers will be probably sufficiently strong to allow of planting direct in the field.

The land selected for the cultivation should consist of dense jungle, with preferably a sandy loam soil. The undergrowth should be cleared, leaving only the larger trees and palms to form

sufficient shade for the protection of the plants. When transplanting the suckers into the cleared jungle, the plants should each be taken up with a good ball of earth, so that the roots are disturbed as little as possible. The most suitable planting distance is about 10 to 12 feet apart.

It has been shown by experiments carried out by the Department of Agriculture that this plant cannot be grown in the open, nor does it appear to thrive even when shaded by mature rubber, and therefore the provision of shade as described above is absolutely essential.

Extraction of Fibre.

The native method of extracting the fibre is as follows:—The leaf is laid on a flattened log and the native, holding one end of the leaf with his foot, scutches away the waste material by means of a long stick with a flattened end, until only the fibre remains. This is a slow and wasteful method and commercially impracticable.

Considerable difficulty has been experienced in designing a satisfactory machine for the decortication of this fibre on a commercial scale to replace the native method described above. It is stated, however, that these difficulties have now been overcome, although no details of the new machine are yet available.

Yield of Fibre.

Mr. Dawe refers to the probable production of fibre as follows:—"A surveyor, who has made a careful survey of the Chiriguana forests, estimates that the "pitales" contain from 5,000 to 8,000 plants per acre, and even more in the richer parts. Sisal or henequen is planted in East Africa at from 900 to 1,000 plants per acre, in certain other countries as many as 2,000 plants are put to the acre; it will therefore be seen that the natural stocking of these "pitales" is very much higher than the usual stocking per acre of sisal plantations."

"It is estimated that the Pita plant will afford 30 leaves per year in two cuttings (in Mexico the henequen plant yields 25 leaves per plant per annum). If we take, to be conservative, the minimum stocking above referred to, viz., 5,000 plants per acre, there would be an annual production of 150,000 leaves per acre. Now 100 leaves weigh from 66 to 70 lbs., according to two independent experiments, so taking the mean of the two computations, viz., 68 lbs., the 150,000 leaves should weigh 102,000 lbs."

"It has been found that, by the native hand method of extraction every 100 leaves or, say, 68 lbs., yields 2 lbs. of dry fibre. It is calculated, however, that there is a loss approximating to nearly 40 per cent. of the actual fibre content of the leaf, which would therefore be about 5 per cent. Allowing, however, for the recovery of only 3 per cent. by mechanical extraction, it will be seen that the return per acre should be 3,000 lbs. or, say, about 1½ tons of dry fibre."

As a plantation proposition, with a planting distance of 10 feet apart either way, giving 435 plants per acre, it is obvious that the above estimate would, until the plants commenced to sucker, have to be reduced, to at least a tenth part of the amount of dry fibre shown, viz., 2½ cwts. of fibre. No information is available at present as to the rate of suckering of the plants, but it is to be seen, that, unless this is fairly rapid, comparatively poor yields of fibre in the earlier years of production will be forthcoming, if the estimate given by Mr. Dawe is correct. Further investigations may show the advisability of closer spacing of the plants.

Commercial Valuations of Fibres.

A sample of the hand-prepared fibre from the Chiriguana "pitales" was forwarded in 1918 to the Imperial Institute, London by Mr. M. T. Dawe, F. L. S., for examination with the following results:—

		Per cent.
Moisture		... 9.8
Ash	(calculated on dry fibre)	... 0.6
a-hydrolysis, loss	" " " "	... 12.6
b-hydrolysis, loss	" " " "	... 16.8
Acid purification, loss	" " " "	... 2.7
Loss on washing in water	" " " "	... 2.1
Cellulose	" " " "	... 74.7

Length of ultimate fibres: from 1.7 to 6.1 mms., mostly 3.0 to 4.2 mms.

"The sample consisted of clean, well-prepared, soft, lustrous fibre of pale straw tint. The fibre possessed good strength and varied from 8½ to 10½ feet in length.

Commercial experts, who reported on the value of this fibre for the Imperial Institute, stated that it was somewhat similar to sisal hemp obtained from *Agave cantala* in the Philippines and the Dutch East Indies, and that the strands were fairly fine, of good strength and thoroughly well-decorticated. They considered that this fibre could be used as a substitute for sisal hemp, Manila hemp or other hard fibres."

In January 1917 a sample of this fibre was submitted to the fibre expert of the United States Department of Agriculture, who reported as follows:—

"The fibre is of excellent quality, and there would be doubtless no difficulty in finding a ready market for it in this country at the present time at a price equal to that of henequen of Yucatan, *Agave fourcroydes*. It seems very doubtful whether American manufacturers would pay for the fibre in quantity, as much as the retail prices for small lots sold in Colombia. If it can be produced in quantity, however, there would be a ready market for it in this country in lots of many tons.

Further samples have been submitted to merchants and manufacturers and other offers to take the Pita fibre in quantities of 1,000 tons have been received. A large consumer, recognising the excellent qualities of the fibre, has offered to take the whole output of the "pitales" of Chiriguana for the period of three years, giving the current market price for sisal. An important fibre broker judged it "the finest fibre possible."

A sample of the "Arghan" fibre submitted by the Department of Agriculture to the Malay States Information Agency, London for valuation was reported on by Messrs. Cross & Bevan, Analytical and Consulting Chemists as follows:—

"Gentlemen, at the request of the Federated Malay States Government we have submitted your fibre to full investigation, and we may at once say that of the innumerable fibres submitted to us during our long professional practice, of potential industrial importance, Arghan stands out pre-eminent.

The structural qualities of the strands are remarkable, the breaking strain, determined on silk-testing machines, gives number, for weight/length unit, superior to those of the staple textile fibres of all classes. Those who have technical experience will find this statement justified by the following figures, noting that the tests were made on the untwisted strands of the original fibre.

We find a range of 3 0 to 6.1 grammes per 1 denier, for breaking strains; and extensibility 1.8 to 2.5 per cent The 'tenacity' figures are quite remarkable, and they establish the Arghan fibre and fibre substance as a new and exceptional type.

Composition of fibre substance —The samples have characteristics of high standard; the state of preparation probably admits of improvement, when the extraction and purification of the fibre has been reduced to industrial routine.

(1) The percentage of cellulose, 75, is above the average for fibres of this class.

(2) The resistance to alkaline hydrolysis (caustic soda) is good. The above characteristics are those which would be favourably affected by standardised methods of preparation.

(3) The fibre is remarkably free from lignone. The fibre should take premier place as a staple for fine twine, lines and cordages, and from the sample of cloth which you have submitted to us, its textile possibilities are shown to be very considerable.

Sea-Water Immersion Tests.—We subjected a sample of the original fibre in the free state to a month's immersion in the ocean tank at the Biological Station, Plymouth, and it is satisfactory to note that the degree of chemical resistance of the fibre was of a very high order. In the same circumstances, cotton, flax, etc., would have been degraded in composition and entirely disintegrated as regards

structure. On the result of our investigations, which have been prolonged, we have formed a strong view of the importance of your fibre as a technical discovery of great industrial importance."

There is therefore no doubt as to the commercial value of this fibre, and that there exists a ready market at prices equal to the best sisal or Manila hemps which at the present time (March 1924), are approximately £40/- a ton. It is possible that when the fibre is better known it will command a still higher price than either of these fibres on account of its fineness, strength and durability.

Uses.

The Pita fibre is valued by the native of Colombia as the strongest and most durable of its class. Large quantities are used in the manufacture of fishing nets, and for saddlery and leather work. It is also employed for fancy needlework.

Commercially it would be classed as a hard fibre and would enter into competition chiefly with sisal for the manufacture of cordage.

Experiments have been carried out recently with a view to its use as a substitute for silk and the manufacture of cloth with promising results. It is stated to take dyes better than any other fibre of its class. If used for such purposes this fibre would naturally realise much higher prices than if used merely in competition with sisal hemp.

It also possesses remarkable salt-water resisting properties and is therefore useful for the manufacture of fishing net yarns and other classes of marine ropes.

Conclusions.

It should be clearly understood that, although the results of investigations of the fibre are so promising, little information is available regarding either the cultivation of this crop or its yield of fibre under plantation conditions. The plants have been introduced only recently into this country and only when they have reached maturity will it be possible to give a definite opinion as to whether this crop is likely to prove a commercial success. It is as yet too early to say whether the plants will sucker sufficiently to form the dense growth referred to as "pitales." Unless this occurs, it is difficult to see, with the estimated yields available, a return of fibre of sufficient quantity to compete with the other well-known fibres of commerce.

Received for publication 17th May 1924.

PATCHOULI OIL.

By B. J. Eaton and C. D. V. Georgi.

A revival of interest has been shown recently in the production of patchouli oil and several communications have been received from England enquiring as to the present position of the industry in Malaya, which supplies the bulk of the oil of commerce.

In addition, enquiries have been received from two other countries as to the method of treatment and distillation of the leaf in this country.

Apart from the local distillation, considerable quantities of the dried leaf were exported formerly to Europe and America for distillation. The distillers in these countries prefer their own distilled oils owing to the possibility of adulteration of the imported oils.

Historical.

In the latter part of the last century both the cultivation of the patchouli plant and the distillation of the leaf for the production of oil were of considerable importance as a minor industry in Malaya, chiefly on the island of Singapore.

At that period three European distilleries were in existence, the plant being also cultivated locally by the owners of the distilleries. The cultivation of the plant was also carried on by a large number of Chinese small holders on areas of about 1/2 to 1 acre, the small holders selling the dried leaf either to dealers or distillers.

The industry did not continue to flourish, probably owing to overproduction, adulteration and other causes, and two of the distilleries ceased production.

For several years the industry was continued on a very limited scale and passed gradually into the hands of enterprising Chinese. In 1908 Tan Ah Tian of East Coast Road, Singapore, who was then distilling citronella oil on a small scale, commenced the distillation of patchouli oil. From that year until about 1919 the production of the oil was carried out only on a small scale, the oil produced by the Chinese distillers being sold in Singapore to dealers, who supplied the European and American markets.

In the post-war boom of 1919-1920 Tan Ah Tian decided to extend his enterprise and, owing to the high prices then ruling for the product, commenced to export the oil himself, since with his past experience he was able to produce the grades of oil favoured by various buyers in Europe.

This business which is carried on under the name of Chua Seng Heng & Co. is now controlled by the son, Tan Guan Chua, who continues the direct export of the various grades of oil. The capacity of this distillery, which is at present the largest in Malaya, is given as 3,000 to 4,000 lbs. of oil per month.

Recently another grower and distiller, Low Ting Teng (Chop Tye Sin) in Johore has entered this industry. A short account of the cultivation and distillation methods carried out by this distiller has been given in a previous number of this journal (Vol. XII, No. 1. January, 1924). The present capacity of this distillery is about 1500 lbs. of oil per month.

Other distilleries are still in existence in Malaya but are not at present in operation.

Varieties of Plant.

Patchouli oil is distilled from the leaves of the plant *Pogostemon Patchouli*, var (*suavis*) Hk. (*Pogostemon Cablin*, Benth.) Natural Order, Labiatae. The plant is usually referred to as *Pogostemon Cablin*, Benth The word *Cablin* is derived from Cablan, the vernacular name for the plant in the Philippines, where it appears to be indigenous.

There are a number of other varieties of this plant, including *Pogostemon Heyneanus* (Benth.), which also yield essential oils, but the genuine patchouli oil of commerce is produced only from the variety mentioned in the preceding paragraph. The leaves from these other varieties, together with those of other plants, chiefly of the Natural Order Labiatae, are stated to be used as adulterants, especially when the leaves are sold for export. The variety *Pogostemon Heyneanus* (Benth.) is a native of India, where it is grown in gardens; it is also cultivated on a larger scale in Java.

Owing to the intense characteristic odour of the genuine leaf, which is imparted to other leaves of similar appearance used as adulterants, detection is difficult.

Cultivation and Collection.

The cultivated plant is a herbaceous perennial propagated by means of stem cuttings, raised first in nursery beds and later transplanted into the field at distances of about 3 feet by 3 feet. In some cases the cuttings are planted in the field and shaded until established.

The first cutting of the stems can be made after about five to six months and subsequent cuttings after similar periods, depending on the character of the soil, rainfall and other climatic factors. Regular cutting can be carried out for about two years, after which replanting is necessary.

The plant appears to thrive on good undulating land or on low-lying land with efficient drainage. Virgin jungle land, which gives the highest yields, is usually selected.

The stems are cut with a sharp knife or scissors at a short distance from the base and transported to the distillery.

The stems and leaves are spread to dry in thin layers on open cement floors with frequent turning to ensure rapid and uniform drying. In case of rain the material is protected by a suitable covering and is removed under sheds at night to protect from dew. It is stated that the stem yields only a small quantity of oil and that of an inferior quality; on that account sometimes the leaf only is distilled, being stripped from the stems before drying.

In the Johore distillery mentioned above the stems and leaves are dried as described and stored under attap roofed sheds, under which conditions it is probable that a slight fermentation takes place in the heaps.

De Jong, who has carried out experimental investigations on the distillation of this oil, states that the wilting effected by the drying and fermentation of the leaf causes the oil cell walls to perish, thus liberating more oil.[1]

The yields obtained by De Jong from dried or fermented leaf (calculated on fresh material) were similar and about 2½ to 3 times the yield from fresh leaf. The character of the Singapore oils was only slightly affected by fermentation or drying, while the fermentation and drying of the Java leaf had a marked effect on the character of the oil.

No information is at present available as to whether the Singapore distillers adopt any special methods of fermentation in the preparation of oils of special quality.

Distillation of Oil.

The oil is obtained by direct steam distillation of the dried material. A number of stills are connected to a main boiler in which the steam pressure is raised to about 75 per lbs. per square inch.

The stills consist of cylindrical iron vessels, about 6 to 7 feet high and 2ft. 6 inches in diameter, having a capacity of about 2 piculs of dried material.

The material is placed in a number of wire cages or deep trays, which are hung inside the stills by means of wires, in order to facilitate charging and discharging.

In the Johore distillery the dried material is first damped before being placed in the stills. It is possible that the reason for this is to enable a larger charge of material to be packed in the still.

Steam from the main boiler enters the still near the bottom through a 2 inch pipe; the outlet pipe is placed near the top of the still, opposite the inlet pipe, and is connected to a copper condensing coil immersed in a large tank through which cold water circulates.

[1] Tesymannia 1906 and 1909.

A battery of stills in a row, supplied by steam from the main boiler can be connected to a series of condensing coils contained in one large tank.

The condensing coils deliver the condensed water and oil into a trough which leads into a sump, constructed like a Florence flask. The oil is skimmed off and filtered through dry filter paper to remove small amounts of water and any suspended matter.

The distillation of a charge in stills of the above capacity is continued for about 24 hours.

Although the above is a general description of the method of distillation of the oil, it would appear that oils of special quality can only be prepared by varying the conditions, the details of which are known only to experienced distillers.

Chua Seng Heng and Co., prepares four grades of oil, known respectively as "Ordinary", "Medium" "Special" and "Extra Special". Analyses of these grades are given in Table I.

Yields.

A yield of over a half a ton of air-dried leaf can be obtained per cutting from a good first crop and a similar yield has been obtained with a second cutting six months later. The subsequent yield of leaf will decrease and after two years it will be found necessary to replant.

In the Johore distillery, in which the stems and leaf are distilled together, the yield of oil is about 4 to 6 lbs per charge of 2 piculs of air-dried material. (1 picul 133 1/3 lbs.)

Analysis of Oil.

Figures for the analysis of the four grades of oil distilled by Chua Seng Heng & Co., are given in Table I. For comparative purposes figures for the analysis of oil distilled by Low Ting Teng (Chop Tye Sin) and also those for standard Singapore distilled oils (Singapore leaf) are given. The figures for the standard Singapore and European distilled oils have been taken from "The Volatile Oils" Gildemeister and Hoffman, Second Edition by E. Gildemeister (translated by Edward Kremer) Vol. III.

The grade of oil is indicated by (a) the difference in specific gravity which rises with the "higher" grades and (b) solubility in alcohol 90 per cent by volume.

The grades of oils examined also show an increase in laevorotation in the "higher" qualities.

The results of analysis of these oils show that the "Ordinary" and "Medium" grades correspond to the Singapore oils of commerce, while the "Special" and "Extra special" grades correspond more closely to the European distilled oils.

TABLE I.—TABLE SHOWING THE RESULTS OF ANALYSIS OF VARIOUS SAMPLES OF PATCHOULI OIL.

Constant.	Oils from Chua Seng Heng & Co.				Oil from Low Ting Teng & Co.	Average for Singapore distilled oil.	Average for European distilled oils (Singapore leaf).
	Ordinary Grade.	Medium Grade.	Special Grade.	Extra Special Grade.			
Specific Gravity (15.5°C) ...	0.9696	0.9740	0.9814	0.9892	0.9711	0.960 to 0.980	0.966 to 0.995
Optical Rotation ...	-48°.4'	-52°.48'	-53°.48'	-55°.2'	-48° 28'	-47° to -61°	-50° to -71°
Acid Value[1] ...	2.3	2.8	3.5	3.7	2.2	Up to 1.0	Up to 5.0
Ester Value[1] ...	4.1	2.3	3.8	3.6	3.0	1.5 to 7.0	2.0 to 12.0
Solubility in 90 per cent. alcohol, by volume: (a) 15°C ...	Sol. in 6.5 vols.	Sol. in 0.75 vols.	Sol. in 0.5 vols.	Sol. in 0.5 vols.	Sol. in 0.6 vols., addition of from 1.5 to 6 vols. causes turbidity, the sol. becomes clear again on further dilution.	Some oils sol in 0.5 to 1 vol., mostly however in 5 to 8 vols.	Mostly sol. in 0.5 to 1.5 vols., addition of more solvent occasionally causes temporary turbidity. Some oils only sol in 4 to 6 vols
(b) 28°—29°C ...	Sol. in 0.75 vols., addition of from 1.3 to 5 vols causes turbidity the sol. becomes clear again on further dilution.	Sol in 0.75 vols.	Sol. in 0.75 vols.	Sol. in 0.4 vols.	Sol. in 0.5 vols.		

1 Milligrammes of potash for 1 gramme of oil.

Uses.

Pure patchouli oil has a somewhat strong and pungent odour, but, when diluted with alcohol or spirit, the odour becomes pleasant. The oil is used almost exclusively in the preparation of compound perfumes in which the odour harmonises with that of the other ingredients.

Markets and Value of Oil.

At the present time the principal markets both for the oil and leaf are Great Britain, The United States of America and Japan. Several enquiries for the oil and leaf have been received recently from London.

In the "Drug and Chemical Markets" (Vol. XIII, No. 22, New York, November 28th, 1923) it is stated that 90 per cent. of the leaf which is dealt with in Singapore is grown in Sumatra. The balance is grown in Malaya. The imported leaves are shipped in bales of about 280 lbs. covered with sacking. In the case of leaf exported from Malaya, the principal destination is the United States of America.

The average local production of oil is 2,000—3,000 lbs. per month. The oil is shipped in 20 lb. iron drums packed in sawdust, two in a case.

In the first seven months of 1923 the value of the exports of patchouli oil from Malaya amounted to $206,116/-.

The price of patchouli oil has fluctuated considerably during the last three years. In 1920 the oil was valued at $33/- per lb., but the price has since declined, until at the present time the oil realises only about $8/- per lb.

In America an import duty of 20 to 25 per cent. on the value of the oil has been imposed. The American demand therefore is principally for leaf for distillation in the country.

No import duty is imposed in Great Britain and there is also no export duty in Malaya.

Conclusions.

While it is of interest to note the revival of this minor agricultural industry in Malaya, attention should be drawn both to the fluctuating prices and the probability of over-production. Such a product must be regarded as a luxury and not an essential article of commerce; its value therefore will depend always on the wealth of the population which can be diverted to the purchase of such materials.

Received for publication 9th April 1924.

VETIVER OIL.

By C. D. V. Georgi.

VETIVER oil, an essential oil, is obtained by the distillation of the roots of the vetiver plant. This plant is a perennial grass, belonging to the same Natural Order—Gramineae—as citronella grass and lemongrass, in which the leaves contain the essential oil. In the case of vetiver it is interesting to note that the leaves are odourless, the roots being the only part of this plant which yield an oil on distillation.

It is thought that the publication of the results of an investigations carried out recently at the Department of Agriculture will be of interest in spite of the fact that there is only a very limited demand for this oil.

The supply of roots for the experiments was obtained from the Government Experimental Plantation, Serdang, where small areas of this crop are under cultivation.

The roots have been distilled to determine the yield of oil and samples of the oil have also been forwarded to the Malay States Information Agency, London for valuation.

Name of Grass.

Vetiver grass is known botanically as *Vetiveria zizanioides*, Stapf.

This grass is but little known in this country; in India, where it is found widely distributed and where the dried roots are used for a variety of purposes, it is known as *Cus-Cus* or *Khas-Khas*. The dried roots are made into baskets and mats (chicks), the latter being hung on verandahs and moistened with water in hot weather, thus perfuming the atmosphere. Bundles of the roots are also placed between clothes stored in wardrobes or boxes, imparting to the clothes the odour of the essential oil, which in its diluted state resembles sandal wood.

In Java there is also a trade in the dried roots, which are known as *akar wangi*, signifying aromatic root.

Vetiver is also cultivated in Reunion; the root is distilled locally, and the oil exported to Europe.

Cultivation of Grass.

The grass is propagated by root division and appears to flourish best in a light soil, which favours root development. In India, where this plant occurs wild, it is found principally along the banks of rivers and in rich marsh land.

The plant will not thrive under shade, while it is said that root development is stimulated by frequent cutting of the grass.

It has been found that the oil content increases up to the time of flowering, so that if the roots are required for distillation they should be harvested just before this time.

Extraction of Oil.

The roots are dug up, separated from the stems and washed in running water to remove adhering stones and soil, and then steam-distilled. On account of the low volatility of this oil the distillation is lengthy, requiring several hours to complete. In the investigations carried out in the Department it was found that a period of about 10 hours was required to complete the distillation of a batch of roots.

Yield of Oil.

The yields of oil obtained from fresh air-dried roots varied between 0.50 and 0.65 per cent. by weight, that is to say, 1 ton of roots will give 12 to 14 lbs of oil. The weight of roots obtained from the experimental areas was at the rate of about half a ton per acre, corresponding therefore to a yield of 6 to 7 lbs. of oil per acre per crop. Under normal conditions two crops of roots can be obtained per annum, equivalent on the above figures to a yield of 12 to 14 lbs. of oil per acre per annum.

Value of Oil.

The sample of oil despatched to the Malay States Information Agency for valuation was forwarded to the Imperial Institute for report. The following is an extract from their report :

> "The sample consisted of a viscid, dark greenish-brown vetiver oil of good aroma. It was examined with the following results, which are shown in comparison with corresponding figures recorded for (*a*) oil distilled in Europe from dry imported roots and (*b*) oil distilled in Reunion.

	Present sample.	European distilled oil.	Oil distilled in Reunion.
Specific Gravity at 15/15°C ...	1.032	1.014 to 1.042	0.982 to 1.020
Optical Rotation...	Too dark to permit reading	+25° to +40°	+20° to +38°
Refractive Index 20°C. ...	1.524	1.520 to 1.523	1.515 to 1.528
Acid Value ...	35.5	25 to 65	4 to 20
Ester Value before acetylation ...	11.8	10 to 25	5 to 20
Ester Value after acetylation ...	162.0	130 to 160	120 to 150

These results show that the present sample of oil is of normal character.

Commercial Valuation.

The chemically dried oil was regarded by experts as of good aroma, resembling in this respect Réunion vetiver oil rather than Indian. They considered that it would be worth 30s. per lb. ex wharf London (January 1924) but were of opinion that the price of vetiver oil might fall in the near future."

Uses of Oil.

Vetiver oil is used exclusively in the preparation of compound perfumes, in which the oil, on account of its low volatility, acts as a valuable "fixer" for more volatile essential oils.

As in the case of other essential oils the utilisation of which is restricted to similar purposes, it is unlikely that the demand for this oil will ever be extensive.

Received for publication 5th April 1924.

TITI SERONG RICE EXPERIMENT STATION.

By H. W. Jack.

IN view of the increasing interest which is being shown in experimental work with rice, it has been suggested that a brief note describing the principal experiment station under the auspices of the Agricultural Department should be published.

The principal rice experiment station is situated at Titi Serong, which is three miles distant from Parit Buntar, the head-quarters of the Krian District of Perak, a district well-known on account of the excellent irrigation scheme established by the Government some twenty years ago to irrigate 56,000 acres of flat clay land for rice cultivation, and for the prosperous condition of its population which is almost entirely agricultural.

The station comprises approximately 21 acres of good padi land and was selected in the first place, becouse it is the centre of a thriving cultivated area; and secondly, because it is abundantly supplied with water since a distributary channel from one of the branches of the main irrigation canal discharges water almost directly in the area.

Unfortunately, though the land is so well supplied with water there is great difficulty in draining off the land prior to harvest and maintaining it dry for the few months between the seasons, because the whole area appears to be situated in a slight depression of the land and because the nearest outlets for excess water are some miles distant, and those outlets themselves are becoming shallow and choked with silt deposit and need dredging periodically. Consequently, whenever rainy weather occurs during the harvesting period it is impossible to drain the land and harvesting operations have to be carried on in 6 or 8 inches of water or more, rendering the labour more arduous and causing considerable loss of crop. This drainage difficulty was only discovered 2 years after work had commenced when a wet harvest was encountered.

In the the third place, this land was selected because it was the best available area within a reasonable distance of Parit Buntar town where the Officer-in-Charge of the station resides.

The land lies adjacent to a fairly good road from which there is a cart entrance to the commodious field store standing at the west end of the fields which run from East to West.

The field store in essentials consists of a cement paved floor, 2,500 square feet in area, covered by a tiled roof and fenced on the east by expanded metal and on the remaining sides by plank walls. One-third of the store is rendered rat-proof by means of half-inch mesh wire netting. This part, amply provided with tiers of shelves,

constitutes the temporary field store as distinct from the main part of the building which is more a covered working space for threshing, winnowing, and other operations connected with harvest, than a store.

Attached to the field store is a tiled drying floor, 1,200 square feet in extent, suitably inclined to facilitate rapid drying and raised one-and-a-half feet above the general ground level. This drying floor is most useful, not only for drying padi, but as a solid platform on which to deal with numerous lots of padi, for it must be remembered that the ordinary soil level is often moist and in rainy weather is frequently submerged even during harvest.

When lots of padi are quite dry they are bagged and labelled and removed to Parit Buntar to the permanent rat-proofed store, to await distribution or study of characters required for definite records. This permanent store is part of the ample building which is used as an office and laboratory by the Officer-in-Charge, locally, of padi experiments.

The land at Titi Serong is divided by "batas" into four "bendangs," each "bendang" being about 5 acres in extent and averaging approximately 600 yards in length.

The work carried on in the station has already been described in Bulletin No. 35 of this Department, but it may be mentioned that the chief item in the programme of experiments is the selection of heavy yielding strains of padi, their isolation, field testing and finally, their multiplication for distribution to rice planters with a view to raising the average annual crops obtained in the country.

Other experiments embrace variety tests, milling tests, the effects of manures and of different methods of cultivation, crop rotation, and cross breeding between the best selections and strains showing desirable characters for the purpose of endeavouring to establish still better strains.

Already the main work, selection, is showing good results and several strains of seed which have been distributed have proved better than local unselected seed in various parts of the country, but particularly in the Krian District in which it is estimated that at least 1,500 acres were planted with selected strains during the last season, in practically every case, with benefit to the planter.

Wherever selected seed was grown in the last season, it attracted considerable attention not only on the part of the Malays but also on the part of the Chinese, who cultivate some 10,000 acres of padi in the Krian District, and demands for seed for the next season are already numerous. Selected seed is popular not only because it produces a large crop but because the padi is heavier than that derived from unselected seed by at least 8% since all the grains are well filled —a result of selecting the seed solely on weight returns; moreover, selected grain gives a high percentage of rice in milling. Amongst other prominent characteristics of selected seed is its absolute uniformity in maturation (which reduces loss in harvesting to the minimum) and the absence of too much foliage.

In March last, the station was favoured by a visit from H. H. The Sultan of Selangor and his staff, the Dato Lee Kong Lam and several notable Malays from Selangor, Negri Sembilan and Perak, and some 250 other interested persons in different part of the country. H.H. The Sultan of Selangor showed great interest in the work; that he possessed a considerable knowledge of things appertaining to padi cultivation was amply evidenced by his pertinent questions and remarks.

Through the Inspection Division of the Department, tests of various selected strains are being carried out in different parts of the country, where conditions differ from those existing at the Titi Serong Station, to ascertain whether some of the strains already selected may be suitable for other areas as well as in Krian. In this way, strains selected in Krian have been found useful in various other places, and are gradually displacing the varieties previously grown. A limited quantity of selected seed padi is now available for distribution to applicants who should communicate with the Economic Botanist, Department of Agriculture, Kuala Lumpur. Rice work is still in its infancy in Malaya, but continuity and perseverance promise beneficial results in increasing local yields and reducing the very large annual imports of the chief food of our labouring population.

Received for publication 8th April 1924.

SMALL POWER RICE MILLS FOR ESTATES.

THE adoption of small power mills for hulling padi is slowly but surely gaining favour on estates situated within easy distance of regular padi markets.

This course of events is only natural because those estates which have been the pioneers in establishing their own mills have found them to be greatly advantageous.

Amongst the advantages which have been found to accrue from estate milling, the most important consideration is the effect on the labour employed. On one estate it has been found possible to purchase padi, mill it, and sell the rice to the coolies at 7 9 cents per gantang cheaper than the neighbouring shop rates after deducting a small percentage of the profits towards covering capital expenditure and depreciation.

This large reduction in the price of estate milled rice as compared with rice bought in the local shops is, of course, only possible to the estate referred to, because it is particularly conveniently situated as regards a padi market, but there are many other estates in the north of the Peninsula which could purchase padi almost as easily. For instance, another estate located several miles from a padi market retails estate milled rice to its own labour at 1 cents a gantang less than the local 'kedai' price.

Thus by milling their own rice, estates situated near areas where rice production is in excess of the demands of the local population can supply their labour forces with rice at a rate varying from a small percentage up to something around 15% less than the local market rates.

This reduction in the cost of rice, small as it may seem, is a very material consideration with coolies, particularly as the cheaper price is also coupled with full measure as compared with the usual shopkeeper's method of giving short measure, and tends to stabilise labour on these estates.

Moreover, estate milled rice (parboiled) is sweeter in flavour than commercial rice, because the water in which the padi is soaked before milling is changed, and is consequently cleaner.

Received for publication 17th March 1924.

AGRI-HORTICULTURAL SHOW AND TRADES EXHIBITION.

WE have received a copy of the Agriculture section schedule in connexion with the forthcoming Agri-Horticultural Show and Trades Exhibition, to be held on the Race Course, Kuala Lumpur on July 11th, 12th and 13th, 1924. The schedule is comprehensive and the prizes offered are considerable. We note that, in the main classes for Rubber, exhibits are to consist of a whole case: this should make for fairer judging, as the exhibits will be, presumably, of average commercial standard. The Section Secretary is Captain J. M. Howlett, M.C.; and copies of the schedule can be obtained on application either to him or to the Hon. Secretary, M.A.H.A., P.O. Box 274, Kuala Lumpur.

(7-6-24.)

LONDON MARKET PRICE LIST, 2nd QUARTER 1924.

Oil Seeds.

Castor (Bombay)	-	£21.	per ton.
Copra (Ceylon)	-	£29.	,, ,,
Do. (Straits)	-	£26 15	,, ,,
Cotton (Egyptian)	-	£13.2.6.	,, ,,
Do. (Bombay)	-	£10.	,, ,,
Croton	-	£27/6—32/6	per cwt.
Desiccated Coconut (fine)	-	44/-	,, ,,
Do. Do. (medium)	-	44/-	,, ,,
Do. Do. (coarse)	-	45/-	,, ,,
Gingelly (Chinese)	-	£27.10.	per ton.
Do. (Bombay)	-	£25.17.6	,, ,,
Groundnuts (Gambia, undecorticated)	-	£15.15 0	,, ,,
Do. (Chinese, decorticated)	-	£21.7.6	,, ,,
Linseed (Bombay)	-	£20 2.6	,, ,,
Do. (Plate)	-	£17.13 9	,, ,,
Palm Kernels (West Africa)	-	£18.15.	,, ,,

Oils.

Castor (Madras)	-	58/6	per cwt.
Do. (pharmaceutical)	-	69/-	,, ,,
Do. (1st pressing)	-	64/-	,, ,,
Do. (2nd pressing)	-	62/-	,, ,,
Coconut (Cochin)	-	50/-	,, ,,
Do. (Ceylon)	-	44/-	,, ,,
Cotton seed (Egyptian, crude)	-	39/9	,, ,,
Do. (Bombay)	-	37/-	,, ,,
Groundnut (Oriental, crude)	-	46/-	,, ,,
Do. (English)	-	47/-	,, ,,
Linseed (Calcutta)	-	39/-	,, ,,
Do. (Plate)	-	38/-	,, ,,
Palm (Lagos)	-	£36	per ton.
Do. (Sumatra)	-	£35.17 6	,, ,,
Palm kernel	-	40/-	per cwt.

Oil Cakes.

Coconut	-	£9.10	per ton.
Cotton (Egyptian seed)	-	£8.	,, ,,
Do. (Bombay seed)	-	£7.	,, ,,
Groundnut (undecorticated)	-	£9.17.6	,, ,,
Linseed	-	£10 15—£11.15	,, ,,
Palm kernel	-	£7.5	,, ,,

Essential Oils.

Cajeput	-	3/2—3/3	per lb.
Camphor (Chinese, crude)	-	2/10	,, ,,
Do. (Japanese, refined)	-	3/1½	,, ,,

Essential Oils.—*contd.*

Camphor (oil)	-	62/6—65/- per cwt.
Cinnamon (Ceylon, leaf)	-	5½ per oz.
Citronella (Ceylon)	-	3/6—3/7 per lb.
Do. (Java)	-	5/- ,, ,,
Clove	-	7/6—7/9 ,, ,,
Lemon grass (Cochin)	-	3/10 ,, ,,
Lime (West Indian, expressed)	-	9/- ,, ,,
Do. (,, ,, , distilled)	-	5/- ,, ,,
Patchouli (Penang)	-	18/6 ,, ,,
Do. (Mysore)	-	25/- ,, ,,
Vetiver (Bourbon)	-	46/- ,, ,,

Spices.

Capsicums (East Indian)	-	40/- —45/- per cwt.
Do. (Nyassaland)	-	60/- —65/- ,, ,,
Chillies (Zanzibar)	-	40/- —45/- ,, ,,
Do. (Nyassaland)	-	50/- - 55/- ,, ,,
Do. (Japan)	-	125/- ,, ,,
Cinnamon (Ceylon)	-	9d. —1/- per lb.
Cloves (Zanzibar)	-	11½d.—1/2 ,, ,,
Do. (Penang)	-	2/6 -3/- ,, ,,
Ginger (Japanese, Cochin)	-	80/- —95/- per cwt.
Do. (Jamaica)	-	145/- -180/- ,, ,,
Mace (Bombay & Penang)	-	2/- —2/10 per lb.
Nutmegs (Singapore & Penang)		
110's	-	2/- ,, ,,
80's	-	2/2 ,, ,,
64's—57's	-	2/3—2/4 ,, ,,
Pepper (Singapore, black)	-	4¾d. ,, ,,
Do. ,, , white)	-	7¾d.—8d. ,, ,,
Turmeric (Bengal)	-	90/- per cwt.

Drugs.

Areca	-	15/- per cwt.
Cinchona Bark	-	According to analysis
Cocaine (hydrochloride)	-	17/- —17/6 per oz.
Ipecacuanha (Rio)	-	9/- —9/3 per lb.

Natural Dyestuffs and Extracts.

Annatto (seed)	-	1/4—1/5 per lb.
Gambier (black)	-	65/- per cwt.
Do. (cubes)	-	75/- —80/- per cwt.

Gums and Resins.

Damar (Singapore)	-	30/- —150/- per cwt.
Do. (Batavia)	-	120/- —160/- ,, ,,
Dragon's blood (reeds)	-	£18—£20 ,, ,,
Do. (lump)	-	£11—£28 ,, ,,

Fibres.

Cotton (American Ord. to F. L. M.)	-	15. 45d.— 17. 15d per lb.
Do. (Egyptian Sakellaridis, G F. to Fine.)	-	23 40d.– 25. 70d " "
Hemp (sisal)	-	£21 —£16 per ton.
Do. (Manila, J. Grade)	-	£39. " "
Do. (Mauritius)	-	£33 -£37 " "
Do (New Zealand)	-	£35 --£37 " "
Kapok (Java)	-	1/2½ " lb.
Do. (Indian)	-	11d. " "

Foodstuffs.

Cocoa (Ceylon, plantation)	-	60/-—100/- per cwt.*
Coffee (Malay, plantation)	-	90/-—120 - " "
Do. (Malay, Liberian)	-	60/- — 70/-" "
Sago (pearl)	-	28/- —30/- " "
Do (flour)	-	17/6 -18 6 " "
Sugar (white, Java)	-	25/6 per cwt. (ex. duty.)
Tapioca (Penang, flake)	-	3¾d.– 4d per lb.
Do. (Penang, flour)	-	18/- 22/- " cwt.

Miscellaneous.

Guttapercha (genuine)	-	2/9 -6/- per lb.
Do. (Sarawak)	-	3/- -4/- " "
Do. (Siak reboiled)	-	10d. " "
Jelutong	-	£30 £60 per ton.

Chemicals.

Acetic acid (glacial)	-	£71 -£73 per ton.
Do. (80% comml)	-	£17.10 - £18.10 per ton
Acetone (pure)	-	£100 - £101 " "
Ammonia (.880)	-	£32 £34 " "
Calcium acetate (grey)	-	£19 10 - £20 10 " "
Citric Acid	-	1/6 per lb.
Creosote	-	8d. per gallon
Formalin (40% vol.)	-	£62 - £63 per ton
Lime juice (raw)	-	1/9- 2/9 per gallon.
Do. (concentrated)	-	£21 per basis †
Sodium bisulphite, (60 62%)	-	£20 —£22 per ton.
Sodium sulphite (anhydrous)	-	£26.10 - £27 10 per ton

* Prices of Cocoa and Coffee are given in bond.

† Basis — 108 gallons, 64 ozs Citric acid per gallon

Received for publication 23rd June 1924.

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; the Raffles Museum, Singapore; and the Malay States Information Agency, 88, Cannon Street, E C London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I IV	(1913-16) VIII & IX (1920-21)		price	$5.00 per volume.
Vol. V	(1917)	Nos 1, 2, 3, 5 & 6	„	2.50 per set.
„ VI	(1918)	„ 1, 7, 8 & 12	„	2.00 „
„ VII	(1919)	„ 2—6	„	1.50 „

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

Vol. X (1922) Price $5.00 per volume.

„ XI (1923) Price $5.00 per volume or 50 cents per single number.

Back numbers of Vols. I X will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased at the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co.

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, Government Entomologist, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher.
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, Government Entomologist, 1910, reprint 1916, 20 cts.
4. A Lepidopterous Pest of Coconuts, *Brachartona catoxantha, Hamps*, by H. C. Pratt, 1909.
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909.
6. Preliminary note on a Branch and Stem Disease of *Hevea Brasilienisis*, by W. J. Gallagher, 1909.
7. Coffea Robusta, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910.
9. Die-Back Fungus of Para Rubber and of Cacao, by K. Bancroft, 1911.
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher, 1910.
11. Coconut Cultivation, by L. C. Brown, 1911.
12. Padi Cultivation in Krian, by H. C. Pratt, 1911.
13. A Root Disease of Para Rubber, *Fomes Semitostus*, by K. Bancroft, Assistant Mycologist, 1912, 20 cts.

C = Cancelled.

THE

Malayan Agricultural Journal.

Vol. XII. August, 1924. No. 8.

ANNUAL REPORT OF THE AGRICULTURAL CHEMIST FOR 1923.

By B. J. Eaton.

Staff.—The scientific staff during the year was as follows:—

Agricultural Chemist	B. J. Eaton
Asst. Agricultural Chemist	R. O. Bishop
" " "	C. D. V. Georgi
" " "	V. R. Greenstreet
" " "	J. H. Dennett.

The Agricultural Chemist was absent in Australia from the 6th July till 17th October. Mr. R. O. Bishop acted as Agricultural Chemist during this period.

Mr. J. H. Dennett was on leave from the 2nd February till the 15th May.

Mr. R. O. Bishop proceeded on service leave on the 19th October.

Organisation.—The Agricultural Chemist has been responsible for the compilation of all reports and administration and general supervision of all chemical work.

Rubber investigations, and the experimental work on paper pulp and fibres was under the supervision of Mr. R. O Bishop until he proceeded on leave, when Mr. J. H. Dennett took charge of this work.

Major C. D. V. Georgi has been in charge of investigations on oils and fats and forest products of various kinds.

Mr. J. H. Dennett has been in charge of investigations on raw materials for the production of power alcohol and sugar with particular reference to the tapping of nipah palm and the production of alcohol and sugar from the sap of this palm.

Mr. V. R. Greenstreet has been in charge of investigations on soils and fertilisers and various miscellaneous investigations.

RUBBER INVESTIGATIONS.

Researches on problems connected with the quality of raw rubber and the factors affecting variability in vulcanisation have been continued throughout the year.

The following articles have been published on some of the results of these investigations.

"The effect of the oxides of arsenic on the rate of vulcanisation of rubber"

"The deterioration of raw rubber on storage"

A number of experiments have been carried out on methods of preservation of latex in the liquid state for shipment and export.

For many purposes it has been confirmed that ammonia is very satisfactory, although the danger attendant on the use of the strongest commercial solution must not be ignored.

Experiments on the loss of ammonia incurred in pumping latex from one vessel to another and on exposure of the ammoniated latex to the atmosphere have also been carried out.

Experiments have shown that ammonia added to latex increases the time of cure of the rubber prepared from such latex.

Investigations on the method of determination of nitrogen in raw rubber, would appear to indicate that the Kjeldahl method of determination does not include all the nitrogen compounds in rubber and latex. Further investigation on this problem is necessary.

Investigations are in progress on the vulcanisation of rubber with solutions of sulphur chloride with a view to evolving a new method for the laboratory examination of raw rubber.

Further investigations on slab rubber, which are in progress, have yielded interesting results in connection with the difference between the exterior and interior layers of the thick slab and on methods of drying and maturation.

Investigations on sprayed rubber prepared by the Hopkinson's process, United States Rubber Plantations Inc. (General Rubber Co. of New York) have been carried out and are still in progress.

Investigations on the effect of various constituents of the latex incorporated in raw rubber are in progress and a report has already been published in the Malayan Agricultural Journal.

Investigations have been carried out on rubber mixings for the manufacture of soles, flooring-tiles, and for sealing rings for tin cans for packing pine-apples.

The cold vulcanisation by sulphur-chloride of rubber samples coloured by the addition of organic dyestuffs to latex has been carried out for an estate.

Several patent coagulants and anti-coagulants have been examined and reported on and rubber prepared by their use has been investigated. Assistance has been rendered to estates in connection with the preservation, packing and shipment of latex and a number of reports containing advice on the same subject have been prepared.

A number of samples of rubber containing defects such as bubbles "rust" and spot disease have been received and reported on.

A sample of adulterated rubber was received for examination. This was found to contain an excess of mineral matter, amounting in one sample to 19.0 per cent. The adulterant was China Clay.

Oils and Fats.

Fixed Oils & Fats.—Samples of groundnut oil and residual cake prepared in Chinese Wedge presses have been examined. The small percentage of oil in the cake indicated that this type of press is fairly efficient; its chief disadvantage is that the ground seed-meal has to remain in the press for many hours.

A number of samples of oil-palm fruit and palm oil have been examined and the free fatty acid content of samples of the oil determined. All samples, except one, were received from one estate.

Analyses of the fruits examined was found to be in close agreement with samples examined during 1922.

Samples of copra cake from one of the copra oil mills in Malaya have been examined to ascertain the efficiency of the mill and recommendations made to increase the efficiency.

An investigation of Illipe nuts of different species and origin has been carried out. The nuts are imported from Borneo, Siak and Pontianak and sent from Singapore to Europe, where the fat is expressed and is used for the manufacture of chocolates and soap.

The oil content of Roselle seed has been determined and the characteristics of the oil ascertained.

The oil content of a sample of Tengkawang seeds, received from the Conservator of Forests, British North Borneo, has been determined.

Lime Fruit Products.

No further investigations have been carried out during the year, but a visit was paid to the estate cultivating this crop in connection with the consignment of hand-pressed oil of limes, distilled oil of limes and concentrated lime juice to England.

A sample of Kapok seed oil has been examined and reported on.

ESSENTIAL OILS.

A sample of an unknown essential oil, probably a wood oil, has been examined and found to be of little commercial value.

Samples of vetiver (*cus-cus*) grass roots from Serdang Experimental Plantation have been distilled on a semi-commercial scale and a bale of the roots and sample of the oil have been despatched to the Malay States Information Agency for valuation and report.

Assistance and advice has been rendered to one estate in connection with the distillation of citronella oil and the efficiency of an unsatisfactory still and condenser has been improved.

The oil content of several samples of grass from this estate was determined and a large batch of grass from Serdang Experimental Plantation has also been distilled and the oil examined.

Enquiries have been received recently from the Malay States Information Agency for Patchouli oil and investigations are being made. The cultivation of this crop is being revived in Johore.

Citronella grass should prove profitable as a crop at present prices (about 4/9 per lb). The oil from the Malayan Citronella grass is similar in quality to the Java and Burmah oils.

PAPER PULP INVESTIGATIONS.

Samples of paper pulp (and the raw materials) from various bamboos and grasses prepared at the Department of Agriculture have been forwarded to the Forest Research Institute, Dehra Dun, India, to the United Kingdom and to Denmark.

A batch of pulp from bamboos has also been prepared for another syndicate, which is interested in this product.

A batch of pulp has also been prepared and despatched for the making of various exhibits in the Agricultural Section of the Malayan Pavilion of the British Empire Exhibition.

Experimental work included investigations on a number of species of bamboo, lalang grass (*Imperata arundinaceae*) Merker grass (a giant grass grown at the Serdang Experimental Plantation which gave a high yield per acre) Citronella grass (after the distillation of the essential oil) and Napier grass, grown at the Serdang Experimental Plantation.

A report on the bamboos sent to the Forest Research Institute, Dehra Dun, India, indicates that a bleached pulp of good quality can be prepared, from at least one of the bamboos, by suitable treatment. It was shown that the original samples of pulp made at the Department of Agriculture were insufficiently digested due to the inadequate nature of the plant used.

Fibre Investigations.

A bale of roselle fibre has been prepared and despatched to the Malay States Information Agency.

Several reports on samples of roselle fibre received from various sources have been made. Samples of rope made locally from this fibre and used as slings on hatches by the Railway Department have been inspected. This rope showed considerable signs of wear compared with Manila hemp rope, used in a similar manner. This was due partly to the fact that the locally manufactured roselle fibre rope was not made as satisfactorily as the Manila hemp rope.

A batch of Bowstring hemp (*Sansieveira* spp.) has been prepared for the Agriculturist for shipment to Europe.

Reports on samples of fineapple fibre have been prepared.

Power Alcohol Investigations.

Research in connection with the production of Power Alcohol has been concerned mainly with tapping experiments on Nipah Palms.

A preliminary report on the investigations has been published in the Malayan Agricultural Journal and a further report is being prepared.

An investigation of the sugar content of lalang grass, after hydrolysis, has also been carried out at the request of the Secretary of State for the Colonies on behalf of the Board of Industrial and Scientific Research.

This investigation confirmed the results obtained by the Board on samples sent for examination to England, which showed that the total "sugar" content, after hydrolysis with 0.5 per cent. of Sulphuric acid, for slightly varying times and pressure, amounted to about 20 per cent. of the weight of the dried grass. Pentoses accounted for 70 per cent. of the "sugar" content. The optimum time of digestion was found to be about 4 hours at a pressure of 10 lbs. increased at the end of 4 hours to 35 lbs. for about 10 minutes.

Soils and Fertilisers.

Ninety five samples of soil have been examined during the year. These include soils on areas of the cultivation of arghan fibre, tuba (Derris elliptica), cotton, dry padi and ragi, rubber, gutta percha and coconuts. An investigation on the salinity of some coastal soils, in connection with Nipah Palm cultivation, has also been carried out, but the results have not led to any definite conclusion as to the correlation of salinity and suitability for Nipah cultivation, except that the palms appear to flourish best when the salinity is below 1 per cent. calculated as sodium chloride.

An investigation has been commenced in the Pot-culture house to determine the comparative nitrogen fixing values of various tropical leguminous crops and also comparative tests on the values of Perlis Phosphates, Christmas Island Phosphate and Superphosphate.

An investigation of different soils on which oil palms are growing well is in progress.

Fertilisers.

An examination of a large number of samples of phosphate from the Perlis phosphate deposits has been made and a report will be issued later. The results show considerable variation. Some samples consist of calcium phosphate, while others contain aluminium and iron phosphates.

An examination of a number of samples of phosphatic guanos from Gunong Pondok Caves, Padang Rengas, has also been made. These samples are of considerable interest and are also very variable. One feature is the comparatively high content of calcium nitrate in some of the samples.

A sample of sawdust refuse from poultry houses was examined and found to be of little manurial value.

An analysis of the ash of giant mimosa has shown that it contains 40 per cent. of calcium phosphate.

An analysis of residue from gutta percha leaves, after the extraction of the gutta percha by mechanical treatment and treatment with water has shown that this material contains only about 1 per cent. of nitrogen and is of value only for local application in increasing the organic matter of soil.

Feeding Stuffs for Poultry and Cattle.

The investigation of local feeding stuffs for poultry has been commenced. Samples of Mimosa, *Boga medolloa* (*Tephrosia candida*) Maple peas, and samples of prawn and small fish refuse have been examined.

The mimosa and *Boga medolla* compare favourably with clover, while the prawn and fish refuse are valuable for admixture with other feeding stuffs.

A sample of Elephant grass has also been examined to determine its value as a cattle food.

This work is being continued.

An investigation of the hydrocyanic content of lima beans has been carried out. Preliminary experiments have shown that the locally grown samples examined are satisfactory. A report on the work will be published shortly.

A sample of sago refuse has been examined with a view to its possible use as a pig food. It was found to contain a small percentage of crude fibre but the nutrient value is low.

Gutta Percha Investigations.

Investigations, which are nearly completed, are being carried out for the Forestry Department on the extraction of gutta percha from leaves of the plant. This investigation has shown that the method of grinding has a marked effect on the yield. Although the leaves can be ground excellently in an ordinary crepeing machine, it is not possible subsequently to separate the gutta satisfactorily. It has been found however that grinding with edge-runners, similar to those used in the grinding of various oil seeds and cakes, is effective.

A yield of about 2 per cent. of gutta has been obtained from fresh leaves supplied by the Forestry Department from indigenous gutta.

A sample of leaf gutta percha prepared locally has been examined and found to be of good quality in respect of the low content of non-gutta constituents..

Exhibition samples have been prepared on behalf of the Forestry Department, for the British Empire Exhibition.

Damar Resins.

An investigation of damar resins has been carried out for the Forestry Department. The results indicate that the chemical analysis has little bearing on the market valuation of the damars, which are judged chiefly on a colour basis and on the size and cleanliness of the particles. Washings and coarse and fine dust contain a certain amount of bark and dirt. A hot sieving method was adopted to remove particles of bark and dross, resulting in the production of a dark but clear block of resin. About 1 cwt of this material has been handed to the Forestry Department to determine its commercial value.

These experiments on the conversion of "dust" damars by melting have shown that the product darkens considerably which may affect its market value. It remains to be seen whether damar thus treated will command a higher market value than the fine particles of lighter colour, also whether any chemical treatment to prevent darkening can be applied.

Locally manufactured Soap.

An investigation of locally manufactured soaps has been commenced in order to determine their quality and to assist the local manufacturers with advice. Samples of palm oil soap, coconut oil soap and rubber-seed oil soap have been examined. The following raw products are being used in the manufacture of these soaps in addition to the oils and fats mentioned above:—caustic soda (sodium

hydrate) sodium carbonate, bleaching powder, sodium silicate and animal fats.

The investigation has been discontinued owing to pressure of work, but will be resumed later.

Medicinal Plants.

It has been found impossible, owing to pressure of work, to undertake a systematic investigation of various medicinal plants.

An assay of the alkaloidal content of two varieties of Datura has been carried out. The alkaloid scopolamine predominated in both specimens. The cultivation of this plant on a small scale might prove remunerative.

Desiccated Coconut.

Samples of desiccated coconut prepared under different conditions have been examined after storage and a report on the samples has been prepared for publication.

The manufacture of this product is being continued by Ban Teik Bee & Co., at Butterworth.

Miscellaneous Investigations.

Miscellaneous investigations include the following:—

Four samples of tobacco leaf for determination of nicotine content, for use as an insecticide.

Samples of a special coagulant and anti-coagulant have been examined together with rubber prepared by their use. It was found that these samples were not of special value.

The identification of a compound recommended for the prevention of "spot" disease of rubber has been carried out and a report published in the Malayan Agricultural Journal.

A specimen of Akar Sintok (Entada phaseoloides) forwarded by the Forest Research officer was found to contain a saponin. This plant is stated to be used locally for the preparation of a hair wash etc. and is also said to be used for the preparation of hair tonics in other countries. An enquiry has since been received from America for particulars and information and samples are being forwarded.

A sample of a very light wood (Alstonia spp. N. O. Apocynaceae) has been examined and found to be of little value, except possibly for local use as floats for fishing nets.

Two samples of transformer oils have been examined for the Federated Malay States Railway Department.

A sample of creped jelutong "rubber" was examined and found to contain 75.5 per cent. of "resin" and 7.5 per cent. of moisture. The results are normal for crude jelutong.

A proprietory insecticide received from the Government Entomologist was found to contain citronella oil, soap and ammonia.

At the request of the S.I.P.E.F. Agency, a sample of the non-caoutchouc constituents of latex was prepared and despatched to the Firestohe Tire and Rubber Company.

Inventions.

Forty-three reports on applications for inventions have been made during the year.

Special Reports.

In connection with enquiries received from various firms, estates or individuals, reports on the following have been prepared and despatched :—

Manufacture of hydrogen.

Preparation of guttapercha.

Rubber seed oil.

Preservation of latex.

Preparation of rubber by the Spray process.

Local vegetable dyes.

Nipah palm products.

Expression of castor oil.

Manuring of rubber.

Factories for the manufacture of wet native sheet rubber.

New methods of rubber manufacture.

Concentration of latex.

Coconut oil machinery.

Publications.

The following articles have been published by members of the Chemical Division :--

1. Note on Minyak Nyatoh ... by C. D. V. Georgi, M. A. J. Vol. XI, No. 2, February, 1923.

2. Note on Kepayang Oil ... by C. D. V. Georgi, M.A.J., Vol. XI, No 2, February 1923.

3. The composition of Kedah and Perlis Phosphate ... by V. R Greenstreet, M.A.J. Vol. XI, No. 3, March, 1923.

4. Production of Alcohol from Nipah palm ... by B.J. Eaton and J. H. Dennett M.A J., Vol. XI, No. 3, March, 1923.

5. Oil cakes as feedings stuff for Cattle ... by B. J. Eaton, M.A.J., Vol XI, No. 5, May, 1923.

6. Candlenut oil from Aleurites Moluccana ... by B. J. Eaton, M.A.J., Vol, XI, No. 5, May, 1923.

7. Roselle seed oil ... by C. D. V. Georgi, M. A. J., Vol. XI, Nos. 7-9, July —September, 1923.

8. Sodium silicate in Soap manufacture ... by C. D. V. Georgi, M. A. J., Vol. XI, No. 7-9, July—September, 1923.

9. Jelutong ... by B. J. Eaton and J.H. Dennett M.A.J., Vol. XI, Nos. 7-9, July —September, 1923.

10. Factors affecting the rate of vulcanisation of Plantation ... by R. O. Bishop, M. A. J. Vol. XI, November, 1923.

11. Some constituents of Hevea latex ... by W N. C. Belgrave and R. O. Bishop M. A. J., Vol. XI, No. 12, December, 1923.

12. The effect of the oxides of arsenic on the rate of vulcanisation of rubber ... by B. J. Eaton and R.O. Bishop Journ. Soc. Chem. Ind. Vol. XLII, No. 29, July 20th, 1923.

13. Alteration of Rate of Vulcanisation and Deterioration of Raw Rubber during storage ... by B. J. Eaton and R.O. Bishop. Journ. Soc. Chem. Ind. Vol, XLII, No.29, September; 20th 1923.

GENERAL.

The Agricultural Chemist was appointed a member of (1) A Committee: —

(a) To consider the requirements of Governments Departments for routine analytical work and research in chemistry and biochemistry, apart from rubber research, for which separate provision is being made.

(*b*) To report upon the most efficient and economical means of meeting these requirements.

(2) A committee for the Proposed Institute for Rubber Research.

The Agricultural Chemist was also appointed to represent the Governments of the S.S. and F.M.S. at the Second Pan-Pacific Science Congress held in Melbourne and Sydney in August.

Reports on the visit to Australia and on a visit to Java on the return journey from Australia are being prepared.

The Agricultural Chemist with the sanction of the Governments of the Straits Settlements and Federated Malay States also accepted an invitation to be an Advisory and Consulting Member of tho Crude Rubber Committee, Rubber Division, of the American Chemical Society.

ANNUAL REPORT OF THE CHIEF AGRICULTURAL INSPECTOR FOR 1923.

BY F. W. SOUTH.

I.—STAFF.

THE Chief Agricultural Inspector, Federated Malay States, Mr. F. W. South, proceeded to Europe on vacation leave on May 19th and returned on December 18th, 1928. In his absence Mr. F. Birkinshaw, previously Assistant Agricultural Inspector, Perak North, acted as Chief Agricultural Inspector. Inche Mohamed Noor bin Hamzah, Senior Agricultural Assistant, Province Wellesley, was transferred from Bukit Mertajam to Taiping on May 9th to act as Assistant Agricultural Inspector, Perak North.

Mr. T. C. Nock, Assistant Agricultural Inspector, Pahang West, proceeded to England on medical leave on August 13th; he died in London on October 27th 1923. Mr. Nock was an officer with long service in the Department and his loss is deeply regretted. An account of his service is given in the Malayan Agricultural Journal Vol. XI, No. 12, December 1923. Since August 13th the Chief Agricultural Inspector himself has taken charge of Pahang West.

II.—ESTATES VISITED.

The following table shows the total number of estates visited throughout the Federated Malay States, the Straits Settlements and Johore:—

Area.	Estates Visited.	Visited by request.	Visited more than once.	Remarks.
Province Wellesley & Penang	51	5	20	
Perak North	18	7	2	
Perak South	28	9	5	
Selangor	39	11	6	2 visited
Negri Sembilan	42	11	26	thrice
Pahang West	7	—	5	—do—
Pahang East	10	—	7	
Malacca	19	7	4	
Johore	48	13	11	
Additional Visits by C. A. I. or Acting C. A. I.	8	—	—	
Totals.	270	63	86	

The totals include several other visits by the Chief Agricultural Inspector made in company with the Assistant Agricultural Inspector for the area in which each estate is, and consequently entered under the heading of that area. The total of 270 estates visited in 1923 compares with a total of 326 in 1922. The majority of the visits were routine inspections for pests and diseases, or made at the request of Managers to advise on treatment of some particular disease or pest. A certain proportion were, however, in connection with new crops or crops other than rubber, while eleven in Johore were paid at the request of the Rubber Restriction Committee.

III.—Diseases and Pests of Rubber.

1. *Stem Diseases.*

Pink Disease (*Corticium salmonicolor*, B. & Br.):—This disease was newly reported from 24 estates in the Federated Malay States, the Colony and Johore, making a total of 355 estates from which it has been reported. In all 1,265 notices were served requiring the treatment of this disease. Failure to comply with the notices led to 144 prosecutions, of these 131 persons were convicted and fined sums amounting to $1,678.00 with $33.75 costs.

This disease received careful attention on practically all European managed estates. In all districts where the disease is prevalent such estates maintain a pest gang to carry out routine treatment of infected trees.

During a period of wet weather in December the disease became somewhat more prevalent in part of Ulu Selangor district than it had been at any other time in the year. This was due to the illness of the Inspecting Officer and the fact that no other officer was available to replace him.

It is expected that the disease will quickly be controlled effectively in Ulu Selangor, as soon as the officer there is able to return to work, since he has done very effective work in that district for the greater part of the year.

It is pleasant to be able to record that, as a result of demonstrations given by the departmental officers and of the distribution of pamphlets in Asiatic languages, small holders in the badly infected districts are beginning to realise the necessity for treating this disease regularly and thoroughly.

The disease appeared for the first time in the Sitiawan area, early in the year. The cases were sporadic and not numerous. After they had been treated no fresh outbreaks were reported or seen. (Malayan Agricultural Journal Vol. XII, No. 2 pp. 32, 39, and 44).

Mistletoe (*Elytranthe globosa* and *Loranthus pentandrus*) Dalu api or Daun api api (M):—In March a local firm of Estate Agents enquired of the Department as to the possibility of various species of local mistletoe becoming wide spread on rubber and doing

considerable damage to the trees. Local mistletoes were reported by them to be giving much trouble on certain estates, principally in Malacca. The Assistant Agricultural Inspectors made local collections of these plants and observations on their prevalence on different hosts These collections were sent to the Assistant Economic Botanist who examined and identified them. From the records made it appears that only the two species mentioned above are at all common on rubber and that, on the whole, rubber trees are not severely attacked by these parasitic plants which are far commoner on fruit trees and jungle trees. When attacked trees are found they usually receive adequate treatment on estates and treatment is advised and enforced on small holdings. Other species of mistletoe will be referred to later. (Malayan Agricultural Journal Vol. XII, No. 2 pp. 36, 40 and 17).

2. *Bark Diseases.*

Mouldy Rot. (*Sphaeronema fimbriatum* E. & H.) This disease was newly reported from 3 estates in Perak North, 2 in Selangor, 5 in Negri Sembilan and 3 in Johore, making a total of 87 estates from which the disease has been reported. In all 3,596 notices requiring its treatment and control were served ; as a result 342 persons were prosecuted for failure to comply with the instructions given, of these 240 were convicted and fined sums amounting to $1867.00 with $75 75 costs.

During the year the disease spread very considerably. In Perak North it appeared early in December in an area of small holdings around Bruas between 1,000 and 2,000 acres in extent. It also appeared later in the month on some small holdings in the mukim of Sungei Tinggi in Larut District. Early in the year the area originally infected near Padang Rengas became somewhat extended, as a certain number of additional holdings were affected. Only 4 estates in Perak have so far been attacked and on these the disease has been brought under complete control

In Selangor the disease appeared in one small holding in the Labu Malay Reservation and in one or two holdings at Beranang both being near the Negri Sembilan border. Prompt treatment prevented any considerable spread from these centres. In November, however, after a period of heavy rain a serious outbreak of considerable extent occurred in Batu and Setapak mukims near Kuala Lumpur. This is mainly confined to small holdings, only 2 estates being infected.

In Malacca the disease spread steadily throughout the year, so that at the close a large portion of the Settlement was infected to a greater or less degree. The disease is still entirely confined to small holdings, with the exception of the one estate on which it first appeared in Malacca.

In Johore the disease spread considerably in Batu Pahat district. Throughout the year it was very prevalent in Muar district which has now been infected for at least four years.

In nearly all centres the prevalence of the disease has depended considerably on the weather, except in the Muar district of Johore where the general condition of the holdings themselves is such as to maintain a degree of moisture in the atmosphere, that enables the fungus to grow actively at all seasons. The same statement applies to certain of the low-lying mukims on the Malacca side of the Johore boundary.

Everywhere the disease has received the persistent attention of the inspecting officers, while in the more seriously infected centres, or where new outbreaks have occurred, special efforts have been made to impose an adequate control on the disease and staffs of officers have been temporarily increased when necessary.

The freedom from attack of most estates in the more recently infected areas, such as the Settlement of Malacca, and the mukims around Kuala Lumpur, is due to the fact that the majority of such estates employ a settled labour force and do not engage casual coolies locally, so that the coolies do not come in contact with infected trees. There is no doubt whatever that the disease is mainly conveyed to new areas by human agency. A contributing factor to freedom from the disease is the much better opportunity for healthy growth afforded to individual trees on well run estates.

The disease is worst in the small and often neglected holdings of poor and uneducated owners. Even with restriction in force such owners are unwilling to stop tapping for the period of three weeks or a month, necessary for the proper treatment of the disease. Moreover, if infected trees are painted regularly with a disinfectant at intervals of about a week, the fungus, though not eradicated, is prevented from doing serious damage to the renewing bark. Small owners are becoming aware of this and are, therefore, all the more disinclined to stop tapping, though willing to use a disinfectant fairly regularly. In some places holdings owned by absentee Malays are leased to Chinese who have no interest in the alien trees, and merely desire to obtain as easily as possible all the rubber they are allowed to export. In other places Malay owners employ Chinese tappers on a profit sharing basis, with the same result.

Such circumstances often render the enforcement of control measures difficult at first. The inspecting officers have, however, devoted considerable attention to teaching small holders the danger of the disease and the proper measures for its treatment and control. Numerous field demonstrations have been given and this educational work is meeting, on the whole, with a satisfactory measure of success. In many of the infected areas the diseased trees are now regularly painted, with the result that, though the disease is not eradicated, it is kept under such efficient control that only a certain number of cases occur in wet weather, while in dry weather it may entirely disappear. Legal enforcement of control is not neglected when necessary, but it is hoped that in course of time educative methods will teach the more ignorant small holders that they are responsible for keeping their holdings free from diseases and that to do so is in their own interest.

The Department has given much prominence to this disease, because it is considered that it must eventually spread to nearly all those parts of British Malaya where rubber is to be found growing under poor conditions of cultivation. Such areas will serve as sources of infection for better tended properties. It is, therefore, desirable that as many rubber planters as possible of all nationalities should be acquainted with the disease, the damage it can cause, and the ease and comparative cheapness with which it can be effectively controlled. (Malayan Agricultural Journal, Vol. XII, No. 2, pp. 32, 39 and 44).

Black Stripe (*Phytophthora* sp.):—This disease was newly reported from 5 estates in Negri Sembilan, 1 in Pahang and 1 in Johore, making a total of 122 reports in all. There were 39 notices served requiring its treatment, but no prosecutions were necessary. On the whole the disease was not much in evidence, though it is still bad at Jelebu and Pertang in Negri Sembilan. (Malayan Agricultural Journal, Vol. XII, No. 2, pp. 33, 40 and 46).

Cyphella sp.:—During wet weather in January reports were received from 5 or 6 estates in Selangor of attacks of this fungus of which the identity is uncertain. It was sometimes mistaken for Mouldy Rot disease. Only on one estate did it do damage. An account of it is given in the Malayan Agricultural Journal, Vol. XII, No. 2, p. 32. The fungus shows indications of becoming somewhat more virulent on rubber and should be watched.

3. *Root Diseases.*

Fomes lignosus, Klotsch:—This disease is still fairly prevalent on young clearings from which the timber has not been removed. In Johore it has been noticed that young rubber interplanted with tapioca invariably shows a high percentage of infection; the fungus has been found growing strongly on the tapioca tubers.

Both in Johore and elsewhere instances have been found where this disease has done serious damage to mature fields of rubber owing to the neglect of it when the fields were young. (Malayan Agricultural Journal, Vol. XII, No. 2, p. 40).

Other Root Diseases:—*Fomes pseudoferreus*, Wakef., *Ustulina zonata*, (Leo.) Sac., and Brown root disease have been found fairly commonly all over the country.

There were 26 notices issued for the treatment of root diseases but no prosecutions resulted.

Other diseases of rubber such as patch canker, die-back for which 36 notices were issued, brown bast and *Sphaerostilbe repens* were recorded but require no comment. Sun-burn wounds on thin renewing bark, followed by the development of a partly parasitic mould, consisting largely of the fungus Gloeosporium, were occasionally recorded in dry weather.

Among pests white ants (*Coptotermes gastroi*, Wasm.) were fairly numerous, while pig and deer occasionally do considerable damage.

4. *General Sanitation.*

The removal of dead rubber stumps and timber from small holdings has been enforced throughout the year. In all 573 notices were served for this purpose; 39 persons who failed to carry out the instructions were prosecuted; and 34 were convicted and fined sums amounting to $273.00 and $15.25 costs.

On account of extremely bad tapping, rendering the trees liable to attacks of pests and diseases, 191 notices were served. Four persons were prosecuted, convicted and fined a total of $28.00 with $3.00 costs.

IV.—Diseases and Pests of Coconuts.

1. *Diseases.*

A somewhat serious disease of coconut palms was discovered at Benut on the West coast of Johore at the end of the year, by the Inspector of Agriculture. His account is as follows:—

> "Affected trees showed a gradual withering of the fronds commencing from the tips. The outer cycle being usually the first affected. The withering continued slowly downwards, and the frond eventually broke from the trunk or collapsed and hung down from the point of attachment. The fruit in all stages dropped to the ground as the head became invaded, the cabbage being small and badly formed. The disease appears to be infectious as attacked trees are usually in groups.
>
> "Growers state that trees have been affected in the same way during previous years, but the damage done has never been so severe as in the present outbreak. They stated further that the disease was usually observed during the rainy weather following a period of drought, and that at such times the soil water, was very alkaline, and water in wells was not fit for use.
>
> "An investigation of diseased material did not disclose the presence of a causative organism. Instructions were given that dead and diseased trees should be destroyed by fire."

The matter was referred for further investigation to the Mycological Division of this Department.

A few cases of bud-rot and leaf-break were reported from Pahang East.

2. *Pests.*

Beetles.—Black beetle (*Oryctes rhinoceros*, L.) and Red Stripe weevil (*Rhyncophorus schach*, Oliv.) :—The black beetle has continued to be fairly generally present everywhere. The red stripe weevil is

not commonly met with in Province Wellesley, Pahang or parts of Negri Sembilan.

The routine work of enforcing the destruction of all dead and decaying palms, village rubbish heaps, heaps of manure near cattle sheds and other accumulations of decaying vegetable matter, liable to serve as breeding places for these insects, has received regular attention throughout the year. In all 8,747 notices were served for this purpose. For failure to comply with instructions 281 persons were prosecuted; of these 245 were convicted and fined sums amounting to $1,080.00 with $108.50 costs.

Although good work has been done and much rubbish has been destroyed, such accumulations are always liable to recur. Often this is due to casual neglect or forgetfulness on the part of persons concerned. In parts of Kinta, where the black beetle has been much in evidence, new breeding grounds are always being formed. This is because coconut palms on mining land are continually being killed by deposits of slime from new mines, or by neglect, and also because there are numerous cattle owners who are always accumulating manure heaps. In the Klang and Kuala Selangor districts of Selangor control of the black beetle is retarded by the Tamil cattle owners, who continuously accumulate manure and take every possible means to hide it when ordered to destroy it. All attempts to establish a system of disposing of the manure in pits, so that it could be used on Sireh plantations and yet remain free from beetle grubs, have failed. The Assistant Agricultural Inspector, Selangor, remarks that breeding grounds are often overlooked. He found, when visiting Port Swettenham on account of a bad outbreak of beetles in the middle of the year, that many of the heaps of grass cut by Sanitary Board coolies were simply the covers to heaps of decaying cattle-manure from which numerous grubs were extracted.

The red stripe weevil is generally most common in places where sago palms are numerous. The Inspector of Agriculture, Johore, remarks that the sago industry carried on along the banks of the Batu Pahat river is responsible for the encouragement of this pest to a very large degree, as it is not possible to supervise the destruction of the sago palm stumps on the overgrown marshy banks of the river.

The control of these two well known pests will require continual attention from inspecting officers. With a view to lightening this work in time, lectures and demonstrations are being given in some districts to teach small holders the connection between the grubs of these insects and the beetles into which they develop and to impress on small holders the consequent necessity for destroying all accumulations of decaying matter in which the beetles can breed. The mature beetles themselves and the damage they do to the coconut palms are well known to people of all nationalities, but many uneducated Asiatics are ignorant of their connection with the grubs, while some will not even believe it when told. (Malayan Agricultural Journal Vol XII, No. 2, pp. 38, 40 and 46.)

In Pahang East one man was fined $40/- for felling coconut trees without permission under the Coconut Palms Preservation Enactment.

The existence of this Enactment in Johore is not well known among growers of coconuts, consequently palms have been indiscriminately destroyed. Steps are now being taken to check this destruction and make known the procedure required by the Enactment.

Artona (Brachartona) catoxantha, Hamp:—This appeared in Province Wellesley at Permatang Pauh and Permatang Ara in February and at Permatang To Jaya in March. The pest appeared in the first two places 5 or 6 years ago, according to local report, and was recorded at Permatang To Jaya in 1921. In the second quarter of the year outbreaks, not of a serious extent, were recorded at Sungei Kota, Sungei Megat Aris and Kuala Kurau in Krian district. In February a somewhat extensive and severe attack was reported on coconut palms around Batu Gajah town and in May a slight outbreak occurred at Menglembu in Kinta on the same area attacked three year ago. In Selangor there was an outbreak early in the year at Sungei Ayer Tawar (Sabak Bernam district) and later in the year at Sepang. In Raub district of Pahang an outbreak was recorded at Dong in January and in Pekan district at Lepar in May.

Nearly all these attacks were ultimately controlled by their natural enemies, of which the fungus *Botrytis* sp. appeared to be the most important in Province Wellesley and Krian, while a Tachinid fly was the prominent parasite near Batu Gajah.

A small area of trees at Batu Gajah was sprayed with water by the Ipoh Fire Brigade. By this means thousands of caterpillars were knocked off the high trees and subsequently killed. These trees were freer than others from the caterpillars in the next generation of the pest. Unfortunately difficulties in obtaining water prevented the use of the fire engine throughout the infected area.

The pest is difficult to control effectively, partly on account of the difficulty of reaching the tops of full grown palms, and partly because it is necessary to avoid, as far as possible, the destruction, along with the pest itself, of too high a proportion of the insects which in normal circumstances keep the pest under control. (Malayan Agricultural Journal, Vol. XII, No. 2, pp. 34, 41 and 46.)

Other pests recorded on coconuts during the year were nettle-caterpillars (*Setora nitens*, Walk. or a related species) in Penang and Province Wellesley and in Kuala Kangsar district, skippers (mostly *Hidari irava*, More), bagworms (*Mahasena* sp.), the "greater" and the "lesser" coconut spike moth (*Tirathaba* sp. near *trichogramma*, Meyr. and *Batrachedra arenesella*. Walk.), and white flies (*Aleurodicus destructor*, Mask.) from various parts of the country.

Squirrels and rats did a certain amount of damage as usual. In Krian locally made traps for squirrels were in use and gave good results.

V.—Pests of Padi.

Nymphula depunctalis, Gn.:—This insect occurred on experimental nurseries in Province Wellesley and retarded the growth o-

the padi considerably, but eventually disappeared. It was also recorded from three localities in Larut district. Spraying with a solution of tuba root much reduced the numbers of the insects. (Malayan Agricultural Journal, Vol. XII, No. 2, p. 47).

Stem borers:—As the padi crop generally was late these insects were not much in evidence by the end of the year. In Province Wellesley arrangements have been made strictly to enforce the Ordinance protecting the bird known to Malays as ruak ruak. (Malayan Agricultural Journal, Vol. XII, No. 2, p. 85).

Podops coarctata, F. Bena Kura or Kutu Bruang (M):—This pest did some damage in the localities of Trong, Lambor, Bruas and Bota in Perak North. Had the presence of the pest been reported to the District Officers earlier, the damage could have been partly prevented. The same pest did some damage to the 1922-23 crop at Bandar in Perak South owing to lack of water. It is recorded as doing damage in various parts of Johore where the dry condition of the padi fields due to lack of rain rendered control work difficult.

Nephotettix bipunctatus, F.:—This pest did a little damage at Talang Test Station, Lambor, Ulu Selama and Bukit Gantang in Perak North. Spraying with tuba root solution proved effective.

Leptocorisa spp. Chenanggong, Pianggang (M):—The various species of this insect damaged padi at Chemor in Perak, at Johol and Inas in Negri Sembilan somewhat severely, and in the Kota Tinggi district of Johore. (Malayan Agricultural Journal, Vol. XII, No. 2, p. 47).

Mole crickets. (*Gryllotalpa* sp.) Sesorok, Sorok sorok (M):—These did some damage at Bandar in Perak South to the 1922-23 crops owing to the lack of water. They also did damage to newly planted out seedlings at Sungei Mati in the Muar district of Johore. Here also the fields attacked were all very dry.

Rats. These have as usual done considerable damage everywhere. Distribution of barium carbonate at cost price has been continued and in the Colony rat traps have been on sale at cost price.

In Johore barium carbonate was supplied early in the season to all padi growing centres, while a circular on rat destruction in Jawi was widely distributed. Trapping and hunting were practised in a portion of the Muar district and head money was paid by the Penghulu for rats destroyed.

The use of barium carbonate is becoming popular in some centres where its effect has been obvious, more especially where many of the rats killed have subsequently been found. When the dead rats are not found, the Malay rice-grower is liable not to believe in the effect of the poison. A little care in preparing baits has a considerable effect on the results. Instruction in the methods of controlling rats will be continued. (Malayan Agricultural Journal, Vol. XII, No. 2, p. 85).

On the whole, apart from rats, pests have done but little damage to padi during 1923. Far more damage has been done by rain and floods.

VI.—Lalang and Blukar.

As owners of small holdings became once more comparatively prosperous, it was decided that the inspecting officers should take steps to ensure that rubber and coconut holdings should again be cleared from the presence of excessive undergrowth and of lalang. Many holdings had been neglected in this respect during the slump, owing to the poverty of owners. In consequence the growth of the trees had been retarded. Furthermore great encouragement is given to the spread of certain diseases by the moist conditions of environment on such holdings. The work met with a certain measure of success and conditions on small holdings are improving, though it will be some time before they become entirely satisfactory.

The notices served requiring the cleaning of small holdings totalled 6,311. For neglect of instructions 630 persons were prosecuted; 549 were convicted and fined sums amounting to $2,244/- with $153.25 costs. (Malayan Agricultural Journal, Vol. XII, No. 2, pp. 35, 41 and 47).

VII.—Water Hyacinth (*Eichhornia crassipes*, Solms.).

In Province Wellesley this pest is present in important quantities only in the waterways of the Sungei Acheh district and in the Province-Perak boundary drain. The Public Works Department cleared the drains in Sungei Acheh district and the Executive Engineer, Krian, was asked to clear the few bad patches in the boundary drain.

In Perak North only three coolies were employed on this work during the year. On completing the work around Taiping they cleaned the Perak River during August and September. In Krian the two rivers, Sungei Gedong and Sungei Samagaga, and all State Land were cleaned in October and November. The gang returned to Taiping on December 9th. It has been decided to pay off these coolies as soon as the destruction of this plant around Taiping has been completed, and to re-employ them only when the Perak River again requires cleaning, or when there is any special work needing attention. During the year Water Hyacinth on privately owned land and in irrigation canals and drains has been satisfactorily destroyed.

In Perak South during the first half of the year a considerable amount of work in destroying this pest was done on the Perak River and its tributaries. The Sungei Rambutan and areas around Bandar were all cleaned up as well as areas at Kampar, Kuala Dipang and Malim Nawar. Work has now been stopped, but a list of places where the weed is growing is kept and these will receive attention if and when they require it.

In Selangor, as in previous years, a certain amount of attention to this pest has been found necessary in Ulu Selangor, Kuala Selangor and Kuala Lumpur Districts, both on State and on alienated land.

In Negri Sembilan the weed is still found occasionally and destroyed where found. The number of places where it occurs is very much less than formerly. Areas in which it was formerly plentiful are now free.

In Johore the control of this pest is under the various Land Offices throughout the State and its presence whenever noted is reported. It is largely cultivated by pig breeders; it has been noted in Government water ways in Batu Pahat district and has been found in a padi field at Sungei Mati.

The total expenditure on the destruction of Water Hyacinth in the Federated Malay States in 1923 was $1,810.72 from a vote of $6.350.00. This indicates that the pest is well under control. In Negri Sembilan 27 notices were served requiring its removal. Five persons were fined a total of $18 00 for harbouring this pest. (Malayan Agricultural Journal, Vol. XII, No. 2. pp. 36, 12 and 46).

VIII.—Pests and Diseases of Other Crops.

Mistletoes, Species of *Loranthus* and allied genera. Dalu Api, Daun api api, Dalu Gajah (M) :—These parasitic plants are plentiful on fruit and shade trees as well as on jungle trees of secondary growth. Certain species occur at times on rubber as has been recorded above. Their removal when found on cultivated plants is now insisted upon, as they are a pest within the meaning of the Agricultural Pests Enactment.

A collection of the various species commonly found has been made and sent to the Assistant Botanist with notes on distribution and host plants. The result of his investigation regarding the geographical distribution of the species as well as their distribution on various host plants is given in the Malayan Agricultural Journal Vol. XII, No. 3, p. 64.

In Selangor and Negri Sembilan 243 notices were served requiring the destruction of species of Mistletoe. Eighteen persons who failed to comply were prosecuted: fifteen were convicted and fined sums totaling $111.00 and $6.75 costs. (Malayan Agricultural Journal XII, No. 2 pp. 36 and 47.)

Giant snail (*Achatina fulica*) :—An interesting account of this animal is given by Jarrett in his paper "The Occurrence of the Snail *Achatina fulica* in Malaya," *Singapore Naturalist* No. 2, April 1923, p. 73. The Assistant Agricultural Inspector, Penang and Province Wellesley, reports that it has spread to a certain extent to the east of the coastal road leading from Butterworth to the north. It is also present in the compounds of houses round the District Hospital where the land is wet and low-lying.

Shallow trenches filled with saw-dust, as recommended by the Assistant Agricultural Inspector, have proved an efficient protection to a garden against invasion from outside. Lime is said to have been an effective protection in another case, but this is still uncertain. (Malayan Agricultural Journal, Vol. XII, No. 2, p. 36.)

Mango Pests:—The branch borer (*Rhytidodera simulans*, White.) was found to be present on about 26,420 mango trees in Krian district. The majority of the trees in this district were far from healthy. The Government Entomologist advised that all infected parts should be cut off well below the observed point of infection and burnt; and that cut surfaces should be tarred. Considerable improvement is shown in some localities.

The same pest was found on a plantation of young grafted mangoes and treated in the same way. On this plantation a fruit fly was also found. The fruits are now enclosed in cloth bags. Mealy bugs are recorded on mangoes at Tanjong Rambutan, these were treated. The branch borer is present on the majority of mango trees all over the country. (Malayan Agricultural Journal, Vol. XII, No. 2, p. 42).

Coffee:—Plants of Liberian coffee about 18 months old on an estate in Perak South were attacked by the green scale insect (*Lecanium viride*, Gr.). They were successfully treated by spraying with a rosin wash.

Bananas:—Leaf beetles, *Autoserica* sp. and *Adoretus compressus* were recorded on bananas around Taiping. The insects were very active after sunset, but were never seen during the day. They live in the soil. The leaf roller (*Erionota thrax*, L.) was common everywhere as usual. A weevil identified as *Cosmopolites sordidus*, Germ. was found attacking bananas at Muar in Johore. Infected plants were destroyed immediately and no further reports of damage have been received.

Various minor pests and diseases of different plants have been collected during the year and sent to the Entomologist or the Mycologist for identification and record.

IX.—Notes on General Agriculture.

1. *Rubber.*

Throughout the year restriction of output combined with an increase in demand maintained the price of rubber at a figure providing a margin of profit on practically all estates; at the same time sufficient money was available to provide for proper attention to works of maintenance such as drainage, weeding and sanitation. The majority of small holdings were regularly tapped, often somewhat severely, to obtain the full output allowed for exportation.

The increase in price was not such as to cause any reversion to former extravagance in administration of estates and the year's

experience has done much to standardise prices and methods of work. This will be to the benefit of the industry in maintaining expenditure at an economical level, even if the market price of the commodity should rise.

Conservative systems of tapping are now the rule on all estates, one cut on ½, ⅓ or ¼ of the tree tapped every other day are common, while the A. B. C. system of tapping and resting a given area periodically is gaining in popularity. On small holdings tapping is still usually on a V or ½ cut daily, in places even twice a day. Where daily tapping would result in production of rubber in excess of the amount allowed for export, were it continued for the whole of each quarter, it is often found that the trees are tapped for two months and rested for one.

Excessive tapping, as frequently as twice daily, sometimes combined with the use of ladders to give access to tappable bark, is most common on small holdings in flat areas near the coast, where the water table is high and conditions are not suitable for the growth of rubber. In such holdings bark renewal is very slow and severe wounding is common. Consequently the severe systems of tapping in such cases can be taken as a good indication that these holdings could not on a reasonable system of tapping obtain their standard production. In localities where the growth is better there is another explanation of severe tapping. The owner of a holding of good trees will sometimes lease one or two more holdings and tap only the two leased holdings, while resting his own, to obtain the full amount of rubber for export allowed him on all three holdings.

The necessity for preventing loss of valuable surface soil from clean cleared slopes, subject in this country to heavy rains, is now widely recognised by planters. Systems of catchment pits, terracing and the use of cover crops or plants such as Citronella and Lemon grass are in common vogue on estates Under older rubber, where soil covers will not grow well, the growth of strips of grass and low weeds is often permitted.

2. *Coconuts.*

The price of the best quality copra on the Singapore Market rose from $10.80 a pikul at the beginning of the year to $13.10 in April. It fell to $9.75 in July and rose again to $12.14 in December. The average price for the year was $11.80 which was better by about $1.00 than the average price in 1922. Local market prices for the produce of small holdings varied at different places from $7 to $11.50 per pikul. On the coast the price of nuts varied from 2 to 6 cents each and inland it ranged from 5 to 8 cents each.

The Commissioner of Trade and Customs has kindly supplied the following figures showing the export of copra from the Federated Malay States.

State	Quantity in Pikuls			Value in Dollars.		
	1921	1922	1923	1921	1922	1023.
Perak	436,054	698;934	588,771	5,416,972	6,621,465	5,788,380
Selangor	163,516	214,266	218,911	2,054,315	1,982,730	2,289,237
N. Sembilan	1,501	5,970	8,257	21,088	54,617	85,101
Pahang	7,269	9,449	8,089	77,326	83,753	77,683
	608,340	928,619	824,028	7,569,701	8,745,565	8,190.701

There was a decrease in production of 404,591 pikuls as compared with that in 1922. This occurred almost entirely in Perak. The explanation probably is that only a comparatively very small area of young trees came into bearing in that State, while from all accounts the crop from existing areas was, for some reason not yet understood, considerably below that obtained in 1922. The cultivated area in bearing will increase in the next 2 or 3 years and crops may be expected to improve. The outlook for the crop is, therefore, satisfactory as the price obtainable seems likely to remain steady.

The favourable condition of the coconut and copra market during the last few years has been a satisfactory feature of a difficult period. It is, therefore, the more regrettable that the rush for rubber and large profits induced owners, even as recently as 1916 and 1917, to destroy so many of their palms. The fine growth and yield of these trees on many of the coastal lands of this Peninsula, the ease with which they can be cultivated and the steady market for their produce render this industry particularly suitable for Malay small holders. It is greatly hoped that co-operative methods of marketing can be introduced in the near future for the benefit of proprietors of small holdings and that the considerable profits which they now enjoy may be increased thereby.

One large mill in Singapore is carrying on the manufacture of coconut oil and copra cake. It is understood that it is difficult to dispose of the oil, but that cake finds a ready sale in Australia. The manufacture of dessicated coconut at Butterworth appears to be thriving; the plant in the one factory in operation is being increased. The price of dessicated coconut products is fair.

3. *Padi.*

A very satisfactory crop of Padi was reaped in Penang and Province Wellesley for the season 1922-23, though some damage was done by excess of water in the fields at harvest.

In Perak North the crop was only an average one or slightly below the average. Good weather at harvest enabled it to be reaped with very little loss of grain, but a drought early in the season, while the plants were in the nurseries or newly planted out, followed by

heavy rains later, adversely affected the growing plants. In Perak South the crop was satisfactory.

In Selangor it was not particularly good mainly owing to unfavourable weather conditions The small areas in Selangor, frequently silted or otherwise unsuitable, naturally fail to yield well. The best yield recorded was 300 gantangs per acre from 980 acres in Ulu Langat and 100 acres at Jeram. Dry padi on 1,000 acres at Jeram yielded 200 gantangs per acre.

In the West of Pahang the crop was normal, but in Pahang East it was considerably above the average for the East coast.

In Negri Sembilan the crop in those districts where planting was late was better than that in the districts planted earlier, where it was poor on account of the heavy rains in the ripening and harvest seasons. It seems that in some districts the padi season requires altering to a different part of the year. At present the planting often falls in the dry season and the harvest during the wet weather.

In Malacca the harvest for the season 1922-23 was a fair average. Unsuitable weather conditions had a prejudicial effect on the growing crop in 1922. Later, however, conditions improved and the crop was considerably better than was at first expected.

In Johore the crop was unsatisfactory owing to the extensive damage done by rats.

In Penang and Province Wellesley and in Perak planting was much delayed by dry weather. When the rain eventually came it was heavy and persistent and did considerable damage to nurseries and newly planted fields. Eventually, however, the padi grew well and a fairly average crop is expected in most places, unless rain falls again at harvest.

In Selangor a poor crop was expected owing to damage by rain.

In Negri Sembilan and Malacca, as in the north, planting has been much delayed by dry weather. This has not, however, had a bad effect up to the end of the year and good crops are expected. In Negri Sembilan several concrete dams were constructed to control irrigation in Rembau district in place of the former temporary dams. As the Malays neglected to remove the planks promptly in times of heavy rain, floods have in several cases eaten a path through the banks, thus making the dams useless.

In Johore planting was very late and the padi was so young that no forecast of the crop could be given at the end of the year. Hill padi along the west coast, planted by Bugis among young coconuts, suffers much from the ravages of wild pig, rats and birds and the yields are very poor, never exceeding 200 gantangs per jalar ($^4/_5$ acre), while the average is much below this figure.

In Pahang East the crop for 1923-24 was almost entirely destroyed by floods. A small yield may be obtained from Pekan and Pahang Tua mukims, but elsewhere there is not sufficient to supply seed for the next planting.

It is hoped that the draining and bunding of the Bagan Nakhoda Umar area in Selangor will be completed next year and that 20,000 acres of land will thus be much improved.

4. *Fruit.*

The mid-year season in 1923 was good generally, durians, mangosteens, rambutans and pulasans being plentiful and cheap. At the end of the year there was another good season in Penang, Province Wellesley and the North of Perak with fair crops in some other districts.

The pineapple canning industry at Klang has been very quiet during the year, the price offered for fruit was as low as 60 cents per 100 in the main harvest, but rose to $3.00 per hundred at the end of the year.

Four factories are still operating in Johore and during the season were kept plentifully supplied with fruit the price of which ranged from $3 to $5/- per 100. The industry is gradually increasing. One factory is now producing pulped fruit from small pineapples for jam making in addition to canned fruit.

In Singapore this industry has also been thriving and the price of the canned fruit has been maintained at a good level. The price paid by the canners for the fruit is, however, not very remunerative to the growers.

A small orchard of grafted mangoes imported from India was planted in 1920 at Batu Gajah. The trees produced some excellent fruit towards the close of the year.

The orchard on an estate in Perak South, planted largely with imported varieties of grafted citrus fruits from Australia, is doing well. The trees are still too young to yield, but are growing well.

A Malay in Krian has a small but successful orchard of pomegranates. The trees yield well and the best fruits sell for 30 cents each in Penang, while smaller fruits sell locally at 20 cents each.

The Assistant Agricultural Inspector, Perak North, calls attention to the desirability of distributing trees of *Mangifera odorata*, Kweeni (M), of which there are a few trees in two mukims in Krian. The fruit is popular and sells for 10-12 cents each. He also refers to the general occurrence of *Garcinia atroviridis*, Asam Gelugor (M), in Perak North and the general use of the fruit by Malays in curry after it has been dried in the sun for about a week.

A few seedlings of the Brazil Nut tree have been distributed by the Assistant Agricultural Inspectors and arrangements have been made to distribute several more as they become available.

5. *Other Crops.*

African Oil Palm (*Elaeis guineensis*) :—At present only a few estates have actually been opened for this cultivation ; only one is yet producing, but is believed to be making a good quality oil commanding a good price. A few of the others have increased their planted area. There have been one or two applications for land for planting this crop.

Roselle (*Hibiscus sabdariffa, var .altissima*):—One estate in Perak is growing this plant and making a profit from the sale of rope. A few other estates have small areas of it. It has not attracted much attention among Malay small holders. Experience appears to show that it is not a crop that can be profitably cultivated in small plots. It needs too much care in cultivation and subsequently in the preparation of the fibre to warrant cultivation in kampongs on a very small scale.

Cloves and Nutmegs :—Measures are under consideration with a view to resuscitating these industries in Penang. If co-operative methods of marketing were adopted by the Chinese growers their profits would be increased and interest in the cultivation of these plants would be renewed. Seeds of these plants have been distributed in a few places in the Federated Malay States, mostly in Negri Sembilan.

Patchouli (*Pogostemon patchouli*):—The distillation of Patchouli oil in Singapore is being carried on at present by only one distiller who revived the industry in 1912. The leaves used by him are obtained from plants grown in Sumatra by growers who are controlled by the distiller. The value of the oil has dropped considerably during the year and is now only about $8 per lb.

At the present time there appears to be considerable competition from a grower and distiller in Johore where the area under cultivation is slowly increasing.

Tapioca (*Manihot utilissima*):—This crop is still grown extensively on young rubber clearings by Chinese in Johore, more especially in the north where several large factories are operating.

Sago (*Metroxylon sagu*) :—A fairly large industry for the preparation of sago flour is in existence along the banks of the Batu Pahat river in Johore. Only one factory is manufacturing commercial sago : mostly the product is prepared by primitive methods and is sent to Singapore for refining.

Tuba (*Derris elliptica*, Beth) :—A Japanese estate on the Johore river is cultivating this plant on a large scale and is putting a root extract on the market.

Some interest has been shewn in the subject of cattle breeding and fodder grasses during the year and this Department is rendering what assistance is possible.

X.—Instruction.

1. As stated in last year's report the first year's results of experiments at the Padi Experiment Station, Malacca, were disappointing. During 1923 development work was continued, an additional area of land was acquired, ploughed and harrowed with a tractor. The station now contains an area of 23 acres. An area of 18 acres was prepared and planted with pure strains of padi from Krian and with a few well known Malacca varieties from which it is intended to select pure strains. The growth during the year was somewhat uneven. This is to be expected where new land is opened for padi. There is no reason why this Experiment Station should not in time prove as successful as that established some years ago at Titi Serong in Krian. An ample water supply under fairly satisfactory control has now been secured.

2. Testing stations for selected strains of Krian padis were established at Permatang To' Jaya in Province Wellesley and at Talang in Kuala Kangsar district. Eight strains were grown in Province Wellesley These gave satisfactory results, the yields being carefully recorded. The results at Talang were also satisfactory. The work is being continued at both stations. It is hoped to establish one or two more such stations in other localities during 1924.

3. Manurial experiments for padi were started in 1923 in Province Wellesley and at Talang in Kuala Kangsar district. The object is to find suitable manure mixtures to replace the local bat guanos which vary greatly in manurial value and are sold at a high price. On the plots in Province Wellesley one pure strain of padi was sown. No manure was applied, as it is first necessary to test the variations in the soil of these plots by recording the yield on each. At Talang also one pure strain was planted and various manures were applied to the plots. The results will not be fully reliable until after the yields on the various plots have been recorded for several seasons.

4. Distributions of seed of various selected strains of Krian padi, likely to be suitable to different localities, were made to a number of growers in 1922 in various States. A summary of the results of these was given by Mr. F. Birkinshaw in the Malayan Agricultural Journal, Vol. XI, p. 335. Distribution was repeated and extended in 1923 and in several places the crops resulting promise to be in excess of those obtained from local seed. The work has already met with considerable success in Perak and in parts of Malacca and Negri Sembilan and it seems that before long certain strains will be recognised as being the best for certain given localities and as superior to local unselected seed. Experience in places has emphasised the need for proper control of the distribution of selected seed, as pointed out in the article referred to above; without such control lasting results would be difficult or impossible to obtain and

much, if not all, of the selected seed would be wasted in small plots of insufficient size and rapidly become merged with the local varieties.

5. Experiments were conducted during the year on two plots of land near Taiping and on one near Batu Gajah to test the use of various leguminous crops in restoring the fertility of reslimed mining land, thus rendering it suitable for padi. The plots were kindly lent by Mining Companies working with dredges. The experiments have shown so far that the following plants are best able to grow satisfactorily on such land; *Mimosa invisa*, *Tephrosia candida*, *Crotolaria striata* and *C. usaramoesis*. The last mentioned seems likely to prove the most satisfactory of all and to provide a large quantity of fairly soft vegetable material which will decay rapidly and form humus. It fruits and seeds freely and appears to grow well from self sown seed. These experiments are being continued.

6. A very successful demonstration was given by the Economic Botanist at the Padi Experiment Station, Titi Serong, in March. This was attended by numerous Malays, especially penghulus and ketuas. The superior tillering powers and yields of the selected padis were demonstrated and the work of the Experiment Station was explained. Several European and Malay Inspecting Officers attended.

7. Demonstrations in the field and lectures at Mosques have been given in Malay in various parts of the country on different subjects likely to be of local interest

8. A highly successful Agri-Horticultural Show and Trade Exhibition was held by the Malayan Agri-Horticultural Association in Kuala Lumpur from June 30th to July 2nd. The Assistant Agricultural Inspector, Selangor, is Hon. Secretary of the Agricultural Section of the Association: he had no difficulty in filling some 10,000 sq. feet of space with agricultural exhibits. There was a successful Show in Seremban in March and Shows were held in numerous other centres during the year. Officers of the Inspection Division assisted, either as Judges, or Committee Members, or in other capacities, at the majority of these shows.

The Inspection Division also assisted in collecting material for exhibits in the Agricultural Section of the Malaya Pavilion at the British Empire Exhibition to be opened next year. The Assistant Agricultural Inspector, Selangor, became Hon. Secretary of the Agriculture Section Committee, British Empire Exhibition in January 1923. This post entailed a lot of work particularly during the second half year.

The work of the Division has steadily grown and extended in recent years. This has rendered necessary certain measures for decentralisation which it is hoped to put into operation next year. These are expected to relieve the Chief Agricultural Inspector of excessive routine correspondence on subjects of minor importance and considerably to expedite work and improve efficiency.

ANNUAL REPORT OF THE ECONOMIC BOTANIST FOR 1923.

BY H. W. JACK.

Staff.—H. W. Jack, Economic Botanist; W. N. Sands, Assistant Economic Botanist; Inche Ahmad bin Johar, Junior Agricultural Assistant; Inche Din, Junior Agricultural Assistant; Inche Mohamed Zain, Probationary Assistant; and S. Amar Singh, Clerk.

I desire to express my appreciation of the good work done by the entire staff throughout the year.

Padi.—Experimental work with rice was continued and was regarded as the major problem in the programme of work. During the first two months of the year a number of visits were made to areas in Perak where selected seed had been planted in the previous year through the agency of the Assistant Agricultural Inspector, Perak North. These visits clearly showed that natural distribution of departmental seed was taking place, for in several places where only 2-3 gantangs of seed had been sown in the previous year, it was found that the entire crop had been re-distributed to neighbouring cultivators for seed and planted by them. As an example, the Ketua Omar in the Tanjong Piandang Mukim of Krian can be mentioned. He received three gantangs of seed (Seraup 36) 2 years ago and planted a small part of his land with it. This season there are 32 orlongs (over 10 acres) of this padi growing in one block around the Ketua's land, and it is readily acknowledged as a very fine and even cropper by the neighbouring rayats who are already asking for seed. Similar results have been reported in various places. During the present season, distribution has been extended to South Perak and in a small way to Selangor, Negri Sembilan and Malacca, and the following extract from a report from the District Officer, Lower Perak, is worth quoting:—

> "In Bandar and Pulau Tiga mukims, Government padi seed has done extraordinarily well—the plants have tillered wonderfully and the plots are now overcrowded. There is no doubt but that in these mukims, provided the Government padi yields as it looks like yielding, every gantang will be saved for seed and practically nothing else planted next year. Even if not pointed out to me, I could distinguish the Government padi by the extraordinary multiplication of each 'perdu' which is at least twice as thick as any local variety."

Again in Kedah at Telok Kechai, strain S. 52 which was planted on one acre by the Agricultural Officer, Kedah, is acknowledged to be the best crop in the neighbourhood, and the entire crop has been booked for seed by the local cultivators. Similarly, strain R. 3 at Kuala Muda has produced 700 gantangs per acre, though in this area the soil

is particularly fertile. The Assistant Agricultural Inspector, Negri Sembilan, reports that selected seed, though the crops are not yet harvested, promises good result as the standing crops show stronger tillering and are much more even in growth than local varieties.

Selected seed does not succeed under all conditions however, for in parts of Malacca and Province Wellesley such seed has not responded to expectations except in certain areas. In Belimbing in Malacca, for instance, two selected strains P. 1, and R. 13, are reported to have done remarkably well. In one area in Province Wellesley, strain R. 1 has yielded heavily. At the Pulau Gadong Padi Experiment Station in Malacca, Krian selected strains have done very badly compared with local varieties, though the very deep tractor ploughing and consequent upheaval of the raw subsoil may have been the cause of failure, the selected strains not being accustomed to such conditions.

At the test station at Talang (Kuala Kangsar) strain R. 13 yielded excellently last season and was much in demand by the local cultivators for this season's sowing. This strain has been used on that area again this season where the manurial experiments, originally started in 1916 but abandoned in 1918 owing to lack of funds, were once more resumed. Unfortunately, the very prolonged drought has not helped these experiments, for lack of rain led to irregular planting of the plots, some being planted as much as six weeks later than the others. However, good healthy growth is reported though climatic conditions will not be quite similar for all the plots, and hence the reliability of results will be somewhat diminished this season. It was hoped to establish manurial experiments in Province Wellesley also, and a preliminary crop was planted on the land earmarked for this purpose to test its uniformity from the point of view of yield.

At the Titi Serong Rice Experiment Station in Krian, further tests of 77 selected strains were made under pure line conditions, each strain being planted in quadruplicate plots of 100 plants per plot. From the results at harvest the number of strains for continuation tests in the present season was reduced to 34. Each of these has been planted as in the previous season in quadruplicate plots of 100 plants each. In addition to the maintenance of the pure line tests of the best selections, the best 12 strains of the previous season were planted in plots varying in size from ½ an acre to 4 acres for multiplication purposes to meet any demands for seed. Foundation stocks were maintained as in the previous season (280 varieties) and 4 selections from them were planted for intensive yield trials, these selections being included in the pure lines mentioned above.

The last padi harvest was a fairly good one, though yields were slightly below average because of very deep water in the planting season. This season dry weather caused a postponement of sowing with the result that when the floods came, the seedlings were too weak to withstand them and many succumbed, necessitating re-sowing of nurseries in many cases. Apart from these floods which covered the land and submerged all the nurseries from 11th to 16th September, the rainfall has been normal and the plants have picked up well, though the tillering is likely to be below average on account of the weakening effect of the flood.

Owing to the vagaries in the depth of water rats have been unusually destructive this season, all the padi in the neighbourhood of the Experiment Station having suffered badly. Poison baits, particularly arsenic and barium carbonate, served well in checking their depredations, and carbon bisulphide was also used to good purpose on the irrigation bunds.

The results obtained from pure line selection work up-to-date have been recorded in Bulletin No. 35 "Rice in Malaya" which was published during the year under review.

The land being dry during 1923 harvest, an effort was made to establish elementary cultural and manurial work at Titi Serong—6 half-acre blocks of land being used for the purpose.

Each block will continue to be cultivated or manured as it was in 1923, season after season, whenever the irrigation permits. These experiments will form a useful nucleus for future work as a time will come when the fertility of Krian will require to be assisted by cultivation, if good crops are to be maintained.

Considerable interest was taken in pure line selection work by parties of Malay cultivators, Penghulus and other from various parts of the country, who visited the Station just before harvest. Some 250 visitors were shown around the Station, and the methods of selection were explained and demonstrated and apparently appreciated.

The demand for selected seed of the best strains far exceeded the supply, over 2,500 gantangs being supplied to applicants.

In connection with the milling of rice, a circular was printed and sent to Estate Managers, District Officers and others likely to be interested in the matter. It is worthy of note that the use of small power mills, recommended by this Division, is slowly extending amongst estates situated near large rice producing areas, and reports show that they are giving every satisfaction. The use of the 'kisaran' for milling amongst natives who have no available source of power was demonstrated at Jeram and Temerloh and to numerous Malay visitors to Titi Serong, and the Inspection Division of the Department reports that the use of the 'kisaran' is gradually replacing the much more laborious 'lesong' in several places.

An exhibit of padi attracted much attention at the Agri-Horticultural Show which was held in Kuala Lumpur in June.

During the last 3 months of the year a considerable amount of time was given to the collection, fumigation and preparation of the following exhibits for the British Empire Exhibition.

1. Series of large photographs showing the methods of rice cultivation.

2. 35 jars of padi to illustrate varieties of rice.

3. 12 glass-topped boxes (divided) of padi and rice of selected strains, with cards to show yielding ability of each.
4. 12 glass-topped boxes of "other cereals" (maize, ragi, millets etc.)
5. 5 glass-topped boxes of "root" crops (tapioca, groundnut, sweet potato etc.)
6. 8 glass-topped boxes of "Pulse" crops (beans and grams etc.)
7. 1 glass case containing 18 specimens of various rices in ear form.
8. 21 models of padi implements etc.
9. 6 mounted specimens of food plants.
10. Photographs, maps etc., of Krian Irrigation Scheme.
11. Exhibit of coconuts.
12. Exhibit of fibres and ropes (rozelle, hemps, jutes, kapok cotton etc.)
13. Exhibit of paper making materials (bamboo, grasses etc.)
14. Articles on "Cereals" and "Cotton" were written for the Exhibition Handbook which is being prepared.

The exhibits were dispatched at the end of the quarter.

The usual statistics regarding the area under rice and the yields obtained in each district were collected from District Officers and are compiled in the following tables. :—

FEDERATED MALAY STATES.

	1922.			1923.		
	Area in acres.	Yield in gantangs.	Average yield per acre.	Area in acres.	Yield in gantangs.	Average yield per acre.
Perak -	115,296	24,450,591	212	106,734	24,276,546	227
Selangor -	20,862	3,081,834	147	11,635	1,737,172	149
N. Sembilan -	30,695	5,189,654	168	30,756	5,196,151	169
Pahang -	30,061	5,318,347	176	28,472	4,581,861	161
Total F.M.S. -	196,914	38,040,626	192	177,527	35,791,730	202
KRIAN -	54,870	13,925,830	254	54,605	14,484,806	265

STRAITS SETTLEMENTS.

	1922.			1923.		
	Area in acres.	Yield in gantangs.	Average yield per acre.	Area in acres.	Yield in gantangs.	Average yield per acre.
Malacca -	26,409	8,486,024	321	26,500	7,950,000	300
Dindings -	635	110,300	170	695	77,475	111
Penang -	5,150	2,558,000	497	5,150	2,033,040	395
P. Wellesley -	31,000	10,291,000	332	44,700	14,350,000	321
Singapore -	...	...	...	...	...	...
Total S.S. -	63,194	21,445,324	339	77,045	24,410,515	317

UNFEDERATED MALAY STATES.

Kelantan -	179,660	38,924,000	183	169,995	33,799,300	199
Kedah -	129,177	37,302,194	288	147,009	48,452,102	330
Trengganu -	10,830	2,000,000	184	11,000	1,700,000	155
Perlis -	29,621	5,847,200	197	29,125	7,361,920	253
Johore -	15,075	1,485,148	98	16,990	840,001	49
Total U M.S. -	364,366	80,558,542	221	374,119	92,153,323	246

SUMMARY—MALAYA

Total F.M.S. -	196,914	38,040,626	192	177,597	35,791,730	202
Total S S. -	63,194	21,445,324	339	77,045	24,410,515	317
Total U.M.S. -	364,366	80,558,542	221	374,119	92,153,323	246
Grand Total -	624,474	140,044,492	224	628,761	152,355,568	242

Coconuts.—Individual tree yields of fruit were maintained monthly from 450 trees in connection with the study of individual tree variation in yield, the establishment of correlations between type of tree and yielding ability, the examination of periodicity of yield, the search for good yielding trees under estate conditions for further genetic research and the comparison of their yielding abilities for future use as seed producers. A study is also being made of different varieties of local and introduced types with a view to classification.

As effort was made to collect statistics of areas under this crop, and though the following figures cannot be regarded as accurate as the areas are in many cases calculated from the number of trees assuming 50 trees per acre as a fair stand or from copra exports still they show the comparative areas and are probably not very far wrong.

F.M.S.		S. S.		U. M. S.	
	acres.		acres.		acres.
Perak	75,280	Singapore	6,560	Johore	12,500
Selangor	62,120	Dindings	6,000	Kedah	27,550
N. Sembilan	4,850	Malacca	15,000	Kelantan	70,900
Pahang	19,400	Province Wellesley	55,000	Trengganu	8,000
		Penang	15,000		
Total	161,650	Total	127,560	Total	118,950

Grand Total Malaya 408,160 acres.

A much larger area than that indicated in the above figures was reported as planted with coconuts, but as the areas were frequently quoted as land alienated for "coconut and rubber" or "coconut and fruit" or "kampong" cultivation very considerable reductions had to be made based on the average number of trees per acre.

Cotton.—Pure line selection work was continued in 1923, the aims being to maintain pure stocks of the several strains under trial and at the same time to ascertain which types were most suitable for cultivation on a commercial scale in Malaya. Fourteen types were grown as pure lines during the season, selfed seed being obtained of each type and individual plant selections were made of all types except 2 which failed to germinate. Of the above number of types, 4 were Egyptian, 6 West Indian Sea Island, 2 local indigenous, 1 Indian imported, and 1 American Upland. The two types which failed to germinate were the American Upland and the Indian type. Types of Sea Island cotton classed commercialloy as "fine ordinary" grow and yield well but the cotton from them only being used in the luxury trades, for which there is little demand at present, the market for such types is limited; indeed, heavy stocks have accumulated so that there is likely to be no appreciable market for some years to come.

Owing to the market conditions it has now been considered advisable to recommend the cultivation of Egyptian types, such as Sakel and "310" and selections from them, since these types are always saleable though they usually command a lower price than the finer longer-stapled Sea Island strains.

A strain of the fine Egyptian variety "310" (E.B. No. 3) which is now being very extensively cultivated in Egypt, where it is considered to be superior in certain respects to the well-known "Sakel" has grown satisfactorily and yielded well during each of the last two years, and appears to be the best type for local conditions as the lint commands a ready sale in the United Kingdom. The original type was selected by Dr. Lawrence Balls in Egypt on account of the whiteness and length of lint and its productive capacity, and these characters do not appear to have depreciated under cultivation in this country. Grown in the lighter soils, due to the season of sowing and with the requisite attention to pest control, E.B. No. 3 promises to become a useful economic crop in Malaya, though at present it is not so prolific a yielder as some of the finer types. Type E.B. No. 16 is also a promising one. As regards yields of lint, these depend, naturally, on the fertility of the soil, on favourable climatic conditions and on the incidence of pests which are controllable if rightly attacked. The yields of lint in the island of St. Vincent, British West Indies, where some 4,000 acres are planted annually, averaged 95 lbs. per acre over the past 11 years (Report on The Agricultural Department, St. Vincent, for the year 1922, page 28), and it is safe to state that local yields during the past two years have been well up to that average. Of course, very fertile blocks of land in St. Vincent have yielded over 300 lbs. lint per acre, but similarly fertile blocks have produced up to 150 bolls per plant in Malaya which should work out to about 300 lbs of lint per acre.

Enquiries for cotton seed have been received from several sources in Malaya and from Java and small sample lots of seed have been distributed for trial, though it is feared that such small trials will not get all the attention they require to make them a success.

The chief difficulty in establishing cotton in Malaya would appear to be that it is an annual crop and as such requires intensive cultivation as opposed to the extensive methods to which our agriculturists are long accustomed.

Should the market for the finer staples improve, types E.B. No. 4 and E.B. No. 6 are prolific yielders and have been thoroughly tried in Jelebu, Kuala Lumpur and South Kedah, and samples of lint have been priced by the Manchester Spinners' Association at 20-22 pence per lb.

The damage done to cotton plants by insect pests is usually greater on poor soils, so that given good conditions for growth, the loss caused by insects need not be extensive always provided that approved methods of control are practised.

Drugs.—The study of native medicinal plants was rather set back by the inability of the Chemical Staff to undertake analysis of material grown, owing to the pressure of other work. The shortage of staff at the Government Laboratories prevented that Department also from doing the necessary analysis.

The only analyses which were completed were those of the two species of *Datura Stramonium* by the Agricultural Chemist. This analysis showed that in sun-dried leaves, type No. 1 (green stemmed) contained ·4 per cent. of scopolamine and type No. 2 (red stemmed) contained ·25 per cent. Type No. 1 may be valuable commercially and a sample is being sent to the Imperial Institute for valuation.

Samples of the following drug plants were prepared for analysis which did not materialize :—

1. Vitex trifolia.
2. Euphorbia tirucalli.
3. Ocimum basilicum.
4. Croix lacryma jobi (roots).
5. Justicia gandarusa.
6. Bryophyllum ca yenum 6.
7. Jatropa sp. 7.
8. Dionella ensifolia 8.
9. Blumea balsamifera 9.

Botanical.—A study was made of the species of Aleurites producing Candle-nut and Chinese Wood Oils, and a paper on these was written for the Malayan Agricultural Journal.

The different species of Mistletoe attacking cultivated trees were collected and studied in different districts. These were identified and photographed, and an illustrated article on them was prepared for publication.

The small herbarium belonging to the Division was re-arranged and numerous specimens of economic importance were collected, dried and added to it. This is a good nucleus for the formation of a Departmental Herbarium for reference purposes.

As in the previous year a large number of plants were identified for other officers of the Department and planters.

Rubber.- Little attention is given to this crop, though records of individual tree yields are maintained monthly for the purpose of further investigating variation in yield, periodic yields, and of finding high yielding parent trees for ultimate seed selection should such work be made a part of the Department's programme. These records are also useful in connection with vegetative propagation experiments and for the study of genetics

ANNUAL REPORT OF THE MYCOLOGIST FOR 1923.

BY A. THOMPSON.

STAFF.

Mr. A. Sharples, Mycologist. went on long leave on the 17th July. Mr. A. Thompson, Assistant Mycologist, acted as Mycologist from that date. Mr. F. R. Mason, Assistant Mycologist, was principally engaged on investigations of the diseases of the coconut palm.

ADDITIONAL BUILDINGS.

A new culture room and a preparation room were added to the Mycological laboratory in December. These will greatly assist the work of the section.

HEVEA BARK DISEASES.

Brown Bast.—

An experimental area, opened upon up on December 23rd, 1922, was tapped daily on 2 opposite V's each on half the circumference. Daily yields of the rubber were recorded along with records of the rainfall for the year on the plot. Observations on wintering, flowering and fruiting of the trees were made during the period. The bark of each tree was examined microscopically, and records kept. It was thought that information would be available towards the end of the year, but no significant results have been obtained as yet. A control plot was opened up in June; this was given the same treatment as the No. 1 plot.

Mouldy Rot. (*Sphaeronema fimbriatum*).—

This disease has extended its boundaries considerably during the year. It appeared in Kuala Lumpur district towards the end of the year, and in time is likely to become so widespread, that its control will become a matter of Estate routine especially during wet weather. The position need not be considered alarming as it has been demonstrated than an effective and simple control can be procured, at a reasonably low cost.

Moulds.—

From time to time specimens of moulds on renewing bark have been received for diagnosis and enquiries as to whether Mouldy Rot was present or not. In many cases there was no trace of Mouldy Rot, only saprophytes being present. Visits to the areas from which the specimens were received, afforded some evidence that the saprophytic moulds were growing :—

(1) On bark which had been tapped too deeply and which had been affected by the sun.

(2) On thin bark which had been burnt by too strong a solution of certain disinfectants.

Black Stripe. (*Phytophthora sp*).—

Demonstrations of this disease were given to planters, on trees inoculated with the fungus so as to show the different stages in the attack.

A possible new bark disease.—

A number of enquiries were received from Estates at the beginning of the year, in connection with a fungus growth on the renewing bark. This growth is a white mycelium which previously grew over renewing bark from the top corners of the tapped panel forming a sheet of fungus varying from 1"–3" in width. It was not noticed to be doing any damage. During 1923 however, it began to grow lower down the panel and to penetrate the bark to a slight extent, and towards the end of the year a few specimens were received which showed that the fungus was capable of penetrating to the wood. Attempts to inoculate trees have not been successful, and, so far, cultures of the fungus have remained sterile. The latest attack showed that the fungus can appear in 3 weeks on a newly opened cut. In this instance there were four plates of fungus mycelium, about ½"–1" above the tapping cut and varying from 1"–6" in width. The bark beneath the centre of each patch was rotted and the deterioration had spread in to the wood. Up to the present the fungus has proved amenable to treatment by application of Agrisol or Brunolinum. The trouble is not yet very serious as only a few trees become affected at a time. Investigations on this disease are in progress.

Root Diseases of Hevea.

A representative collection of the common root diseases of Hevea, was collected for the British Empire Exhibition. These proved of interest to various planters and visitors who came to the laboratory while the specimens were being dried and prepared.

Fomes lignosus and *Fomes pseudo-ferreus* were the commonest root diseases dealt with in 1923. The latter, especially, was met with on Estates which are increasing their activities in disease control, and searching for cases of root disease.

Die-back.

Several Estates were visited in connection with a dying back of the crown and branches of rubber trees. The trouble was not always due to a specific root disease. In one instance the trees in a small area had been flooded frequently, and as a result were growing in very swampy ground. This undoubtedly was the cause of the die-back.

On another Estate the trouble appeared on ·27 year old trees. The soil in this area was very dry and had been subjected to a steady wash. The trees were very poorly developed and gave little latex. Only a few cases of root disease were found, and the die-back was due to soil wash and starvation of the trees.

Die-back was also encountered on an area of 2 year old trees. The trouble was confined to about three rows where about 30 trees had suddenly died back in a couple of days. A visit to the area revealed the fact that lightning was responsible for the damage. Boring beetles and the fungus *Diplodia* were prominently associated with the dead trees.

PINK DISEASE (CORTICIUM SALMONICOLOR.)

Trouble with bud-grafting was experienced on an Estate in a Pink Disease area. It was found that the bud-wood was being obtained from branches which had been treated for Pink Disease The disease had caused the buds to "start" slightly, and this appeared to be the principal cause of the failure to establish the bud-grafts.

LORANTHUS PENTANDRUS.

This parasitic plant called for attention in the earlier part of the year. It had established itself on a large area of rubber trees in Negri Sembilan. About 60% of the trees in a 200 acre plot were affected, and although the trees were wintering, and had shed most of their leaves, this was not noticable from a distance owing to the luxuriant foliage of the Loranthus. As the trouble was spreading rapidly control measur s were instituted, i.e. pruning the affected branches. The area was then put out of tapping for a few years to allow the trees to recover. The parasitic alga (*Cephaleuros mycoidea*) was noticed, growing on the leaves of the Loranthus.

COCONUTS.

Bud-Rot.—

Bud-Rot as an epidemic disease remains practically non-existent in Malaya. Throughout the whole year only 9 cases have been observed that bore any resemblance to Bud-Rot as described by various writers in other tropical countries. In the majority of cases, when a bud is rotting, it can be put down to some other primary cause or interference with the life processes of the palm.

A New Disease.—

A hitherto unrecorded disease of the Coconut palm has appeared. On one Estate an area of about an acre had been completely wiped out before its seriousness was known. Infection undoubtedly takes place by means of root contact as the palms appear to die off in an ever-widening circle.

The spread of this disease was successfully checked by the digging of isolation trenches. The same disease has been suspected in one or two other localities but has not reached such proportions as in the first instance.

Stem Bleeding.—

More definite information on stem-bleeding has been obtained during the year. There appear to be 3 distinct types.

(1) The common type, which appears to be caused by a disease of the "bark" or outer 1½" of soft tissue, the bleeding taking place from all available cracks in the bark.

(2) Bleeding from abandoned White Ant galleries. These two types do not appear to affect the growth of the palm to any great extent.

(3) A Bleeding, usually occurring from one single wound in the stem and associated with the unrecorded disease described above. This bleeding is so profuse that when the wound is further opened with a knife, as much as ½ pint of pus-like liquid is sometimes ejected with considerable force.

Leaf Spots.—

Pestalozzia palmarum has been reported from practically all districts, but only in one instance has it done any considerable damage, when it practicaly wiped out a small plantation of one year old Dwarf Coconuts.

Red Ring Disease.—

One case of suspected "Red Ring Disease" has been found, but although typical symptoms were apparent, no trace of the nematode worm said to be responsible for this disease, could be found in any of the diseased tissue, so that we cannot record this as a definite case of "Red Ring disease" which, hitherto, has not been reported in this country.

Routine work in the laboratory has been carried on, in connection with diseases under observation.

African Oil Palm.

A case of bent-leaf disease has been observed in young African Oil Palms in the Kuala Lumpur plantation, otherwise Oil palms have given very little trouble.

Gutta percha (Taban Merah.)

Various diseases of Taban have been studied and several visits were made to the Forest Reserves in this connection. Taban seedlings require considerable shade when young, and one (self planted) area

had died as a result of clearing away the natural cover afforded by the undergrowth. The fungus *Diplodia* attacked the weakened shoots and hastened the end.

Black lines were noticed in the collar and roots of young trees and layered Taban plants. These have yielded an interesting fungus which is being studied.

Brown-root disease also occurs on Taban.

Chlorosis of the leaves of seedlings was encountered in one nursery. No organism could be demonstrated or cultured.

TEA.

A visit was made to a Rubber Estate on which a small area was under Tea. This crop was attacked by many diseases probably owing to bad conditions of cultivation.

ROSELLE FIBRE.

Hibiscus sabdariffa var altissima.—

A new disease of this crop was noticed in some pot plants on the Kuala Lumpur plantation.

The tips of the young plants died back rapidly, and in a short time the whole plant withered in a characteristic fashion. The dead portion was covered with pycnidia of a species of *Phoma* but only backward plants seemed to be affected.

Bacterial wilt of Roselle was prevalent on one of the plots of Serdang Experimental plantation. The disease was very marked when the plants were young. Control measures were instituted and appeared to be successful since the crop is now doing well.

Roselle is also subject to the attack of eel-worms and several specimens showing eel-worm attack were examined.

TOBACCO. (NICOTIANA TABACUM.)

This crop was attacked by *Bacillus solanacearum* on Kuala Lumpur plantation. Eel worms were active also and killed about 25 per cent. of the plants in one small plot. *Cercospora Nicotianae* was prevalent; it is more active on the lower leaves and was kept in check by picking these leaves and burning them whenever they became diseased.

TUBA ROOT. (DERRIS ELLIPTICA.)

Pink Disease (*Corticium Salmonicolor*) was recorded as attacking the stems of this plant.

Jerusalem Artichoke. (Helianthus Tuberosus.)

Rhizoctonia sp., did considerable damage to artichokes. The same fungus also attacked *Crotalaria usaramoesis* on Serdang Experimental plantation.

Specimens of Field Corn were received from Johore suffering from an attack of *Helminthosporium* on the grain. The whole plot was destroyed by this fungus. The same crop on Serdang Experimental plantation was not affected.

Borneo Camphor.

An outbreak of root disease caused by *Rosellinia bunodes* was reported from Kanching Forest Reserve. The trouble was taken in hand early and the disease did not spread.

Brachartona Catoxantha.

This dangerous pest of the coconut palm is said to be kept in check to a certain extent by a fungus (*Botrytis sp.*) which parasitises it. Specimens of the fungus were sent to Fiji where a similar pest of the coconut palm does considerable damage.

Mosquito Larvae.

Some time was spent in investigating some dead Anopheline mosquito larvae sent in by the Malarial Bureau. The bodies of the larvae were full of elliptical greenish-brown organisms. These were studied and identified as being similar structures to the sporangia of the fungus *Coelomomyces Stegomyiae.*

Before going on leave Mr. Sharples served on a Committee to report on certain proposals made to the Government for "the formation of a Co-operative Society of Rubber growers to undertake bud-grafting and seed selection work, in connection with Para rubber."

A series of lectures in Mycology were given to the Malay Officers of the Department.

Work in connection with the British Empire Exhibition occupied a considerable portion of the last quarter of the year.

The following papers were contributed to the Malayan Agricultural Journal by the Mycologist.

(1) Preliminary Report on Brown Bast Experiments.

(2) Treatment of Mouldy Rot, (Final Report.)

(3) Black Fruit Disease of Pepper Vines in Sarawak.

ANNUAL REPORT OF THE GOVERNMENT ENTOMOLOGIST, FOR 1923.

By G. H. Corbett.

(1) Staff.

Government Entomologist, G. H. Corbett; Assistant Entomologist, B. A. R. Gater.

Mr. Malcolm Miller, Temporary Assistant Entomologist, resigned his appointment on the 28th February.

Mr. Daniel Ponniah, Insectary Assistant, proceeded to India on leave on the 5th April and reported for duty on the 18th July.

(2) Visits.

During the year 27 Estates were visited by the members of the European staff. Mr. B. A. R. Gater went on two tours of about ten days each through Negri Sembilan, Malacca and Perak.

(3) Publications.

Articles on the following subjects have been published during the course of the year :—

"Preliminary note on *Plesispa reichei*, Chap."

"Summary of observations on *Rhynchophorus schach*, Oliv."

"Food plants of *Leptocorisa* spp."

"Annual Report for 1922."

Special Bulletins on *Rhynchophorus schach*, Oliv. and *Plesispa reichei*, Chap., mentioned in my report for 1922, are now actually in the printers' hands.

(4) Agri-Horticultural Show.

An exhibit of Live Insects harmful to economic crops was prepared.

(5) Insecticides.

The value of *Derris* ("Tuba"), as an insecticide has come up during the past year and plants are being grown in various localities. An effort has been made to collect and compare the insecticidal values of a number of plants indigenous to Malaya. *Derris* has a distinct usefulness as an insecticide in a restricted manner. It cannot at present be compared in efficiency or price with many other new and established insecticides and it is dangerous to make recommendations which would encourage its growth on a large scale until more definite

information is obtained, especially with regard to the toxicity of the various species. It is at present advertised as being non-poisonous to man and animals. This statement is incorrect. It is both poisonous to man and animals to no small degree and is an abortifacient.

There are very few insecticides available in this country and during the year a system of testing the efficacy of insecticidal substances under local conditions has been started. Several proprietary articles have been obtained and examined.

(6) Household Pests.

Advice has been sought on numerous occasions by householders especially with regard to "borers" in timber, bed bugs and ticks. Enquiries of this nature are welcomed and it is hoped that such enquiries will increase. It is noteworthy that many who suffer from the effects of household pests do not know to whom to apply for recommendations as to treatment.

(7) Locusts.

Locusts have already been troublesome in Malaya and there seems to be a general impression that the locust was introduced and that there is no danger of recurrence. *Locusta migratoria*, L. ph. *migratorioides*, Rch and Frm., which is the insect concerned, is well known and except for the Palaearctic Region has the same range as L. *migratoria*, L., ph. *danica*, L., which extends practically through the whole of the Eastern Hemisphere.

It is well known that locusts have permanent breeding grounds and these were never investigated during the outbreak. Breeding grounds referred to in Bulletin No. 24 of this Department obviously deal only with the temporary breeding grounds of migrated swarms. It is probable that permanent grounds are situated in the depths of the forests.

It is most essential that all concerned should realise that another outbreak may occur at any time.

(8) Pests and Cover Crops.

From an entomological point of view the practice of growing cover crops has proved itself on several occasions to be dangerous. Among other instances the following may be mentioned. *Valanga nigricornis*, Burm. seriously damaged young coconut palms growing in a cover crop of mimosa, adjacent areas where no mimosa was growing being entirely free. *Hypomeces squamosus*, F. and *Adoretus compressus*, Weber, both common leaf eating beetles which do considerable damage, are particularly injurious where the soil is not clean-cleared. Slugs damaging young rubber are also harboured by cover crops.

(9) New Species.

The following insects new to science were described from material forwarded to the Imperial Bureau of Entomology, London.

Rhynchota, *Coreidae*, *Leptocorisa corbetti*, China, on Padi.

Hymenoptera, *Chalcidoidea*, *Chalcididae*, *Harmolita aequidens*, Waterston, on Bamboo.

A paper on the various species of *Leptocorisa* found in padi fields in Malaya is practically ready for publication but has been held up awaiting full descriptions of the five species now known to be present.

(10) Investigations of Crop Pests.

(A) *Batrachedra arenosella*, Wlk. (*Cosmopterygidae*) on Coconut flowers in the unopened spike.

Preliminary work extending over several months has been concluded and it is hoped that the results will be published shortly.

The outstanding features are the apparent small actual damage caused by the caterpillars, the enormous amount of fall of flowers and immature nuts due to other causes, and that a 80 per cent. control of this insect has been found.

Tirathaba sp. near *trichogramma*, Meyr. (*Pyralidae*). This moth is the most important pest of Coconut flowers of the opened spike and the caterpillars have frequently been found boring the female flowers.

Detailed work on the life history has been made and field experiments for its control were instituted at the beginning of October. They are still in progress and the results are encouraging.

Two Ichneumonid parasites, neither of which was represented in the British museum, have been discovered, i.e., *Campoplex* sp. and *Anilasta* (?) sp.

Facilities for carrying out both the above series of experiments were kindly provided by managers of the respective estates.

(B) Detailed investigations were carried out on the following insects :—

Scotinophara coarctata, Fb. (*Pentatomidae*) on Padi.

Dysdercus cingulatus, F. (*Pyrrhocoridae*) on Cotton.

Alcides leeuweni, Hllr. (*Curculionidae*) on "Kapok".

Epilachna indica, Muls. (*Coccinellidae*) on Datura.

Spodoptera abyssinia, Gn. (*Noctuidae*) a general feeder.

Achaea janata, L. (*Noctuidae*) on Castor.

Sylepta derogata, F. (*Pyralidae*) on Brinjal.

Antigastra catalaunalis, Dup. (*Pyralidae*) on Gingelly.

An interesting observation was made during the study of *Dysdercus cingulatus*. An insect of the same family, *Antilochus coqueberti*, F., was found to have the apparently unrecorded habit of attacking and feeding upon *cingulatus*, and would appear to be a check of some importance where it exists. It is also interesting to note that the nymphs of *D. cingulatus* are frequently predaceous on sickly or dying members of their own species.

A paper on *Scotinophara coarctata* has already been prepared for publication.

(C) During the year it has been possible to embark on the keeping of a complete record of pests in Malaya on all crops. The greater part of this year has been devoted to the institution and perfection of a system whereby all insects coming into the laboratory are bred out on their food plants and records and observations taken. These are filed in such a way as to be easily accessible for future reference.

During the year more than 800 batches of insects were dealt with in this manner and a position has already been reached whereby an index of insects under food plants is available. A large number of insects can now be identified with certainty by this Division since a collection of correctly determined types is available in the Laboratory.

It might be mentioned in this connection that a large number of economic insects is unrepresented in the British Museum, which emphasises the urgent need of a complete survey of insects affecting crops.

The following is a list of some of the more important insects recorded during the year.

ORTHOPTERA.

Gryllidae.

Brachytrypes achatinus, Stoll. recorded on rubber buds.

COLEOPTERA.

Nitidulidae.

Lasiodactylus pictus, Mch. recorded on Lime and Rambutan fruits.

Erotylidae

Anadastus nigrinus, Wied. recorded on Padi flowers.

Coccinellidae.

Alesis discolor, F. *Chilomenes 4—plagiata*, Swartz. *Coelophora inaequalis*, F. *Scymnus* sp.	Predaceous on Aphids.

Bostrychidae.

Xylopsocus capucinus, F. on *Caryocar villosum*.

Chrysomelidae.

Aulacophora antennata, Baly. on *Pangium edule*.

Aulacophora lewisi, Baly. on Gourds.

Aulacophora similis, Oliv. on Gourds.

Monochirus moestus, Baly. on Sugar cane.

Monolepta bifasciata, Hornst. on Roselle.

Nodina fulvitarsis, Jac. on *Vigna catiang*.

Plesispa nipa, Maulik. on *Oncosperma tigillaria*.

Lamiidae.

Serixia sp. on *Barringtonia speciosa*.

Platyrrhinidae.

Araecerus fasciculatus, DeG. on Tephrosia and Cotton seeds in the field, and Brazil nuts.

Curculionidae.

Odoiporus longicollis, Oliv. on Banana.

Cosmopolites sordidus, Germ. on Banana.

Scolytidae.

Phloeosinus cribratus, Bldf. on Cloves and Nutmegs.

RHYNCHOTA.

Pentatomidae.

Dinidor obscura, Lep. and Sev. on *Erythrina indica*.

Eusarcoris ventralis,, Westw. on Padi.

Menida histrio, F. on Padi.

Scotinophara cinerea, Le Guill. on Padi.

Coreidae.

Leptocorisa acuta, Thnb. on Padi and Grasses.

Leptocorisa lepida, Bredd. on Padi and Grasses.

Physomerus grossipes, F. on *Vigna catiang*.

Reduviidae.

Euagoras plagiatus, Burm. (?) probably predaceous on *Leptocorisa* spp.

Fulgoridae.

Lawana conspersa, Wlk. on *Aleurites montana* and Indigo.

Aleurodidae.

Aleurocanthus spiniferus, Quaint. on Citrus.

Coccidae.

Paralecanium expansum, Var. *metallicum*, Green, on Nutmegs.

LEPIDOPTERA.

Papilionidae.

Papilio clytia clytia, L. on Cinnamon.

Papilio polytes romulus, Cram. on Lime.

Nymphalidae.

Amathusia phidippus, L. on African Oil Palm and Coconuts.

Hesperiidae.

Hasora alexis, F. on *Derris* sp.

Arctiidae.

Amsacta lactinea, Cram. on Tea and Chillies.

Creatonotus transiens, Wlk. on Vanilla.

Cyana ridleyi, Hamps. on Rubber bark.

Miltochrista exclusa, Butl. on Rubber bark.

Noctuidae.

Anomis flava, F. on Cotton.

Heliothis flavigera, Hamps. on Cape gooseberry.

Maranga diffusa, Wlk. on Padi.

Phytometra chalcites, Esp. on Cacao.

Xanthodes transversa, Guen. on Roselle.

Lymantriidae.

Nygmia scintillans, Walk. on Candle nut.

Sphingidae.

Theretra nessus, Dru. on Yams.

Saturniidae.

Attacus cynthia, Drury, on Pili nut.

Cossidae.

Duomitus ceramicus, Walk. on Teak.

Phragmataecia castaneae, Hb. on Sugar cane.

Limacodidae.

Chalcoscelis fumifera, Swinh. on Candle nut.

Cheromethia ferruginea, Moore. on *Derris* sp.

Pyralidae.

Caprinia conchylalis, Guen. on *Ficus elastica.*

Ephestia cautella, Wlk. on Beeswax.

Etiella zinckenella, Treit, on *Tephrosia candida.*

Psara stultalis, Walk. on Patchouli.

Pterophoridae.

Sphenarches caffer, Zell. on Pumpkin.

Eucosmidae.

Stomphastis plectica, Meyr. on *Jatropha curcas.*

Gelechiadae.

Stegasta variana, Meyr. on Groundnut.

Elachistidae.

Pyroderces ptilodelta, Meyr. on Cotton.

DIPTERA.

Agromyzidae.

Agromyza sojae, Zehnt. on Velvet bean.

Trypetidae.

Dacus ferrugineus, F. on numerous fruits.

Tachinidae.

Blepharipoda ophirica, Wlk. on *Taracola plagiata.*

Cyphocera varia, F. on *Spodoptera pecten.*

Thelaira sp. nr. *luteicornis*, Walk. on *Parnara mathias.*

HYMENOPTERA.

Chalcididae.

Brachymeria euploeae, Westw., on *Caprinia conchylalis.*

Tetrastichus sp. on *Artona catoxantha.*

Ichneumonidae.

Goryphus maculiceps, Cam. on *A. catoxantha.*

Goryphus maculipennis, Cam. on *A. catoxantha.*

Xanthopimpla, sp. on *Erionota thrax.*

Xanthopimpla punctata, F. on *Sylepta derogata.*

Braconidae.

Elphea lutea, Cam. (?) on *Topeutis rhodoproctalis.*

Microgaster, sp. on *Artona catoxantha.*

(11) Bees.

Bee-keeping with the local variety of *Apis indica* was started during the year and certain progress made from the entomological point of view.

Apis indica has not proved to be a suitable bee in India and it has yet to be found so in Malaya.

Our results coincide with those obtained by Mr. Ghosh at Pusa, that *Apis indica* is a poor honey gatherer, extremely prone to swarming and cannot protect itself against the wax moth. The Italian bee has been found capable of resisting the latter pest which is very prevalent in Malaya.

It will probably be found that it is on the lines of obtaining a suitable bee for this country that a bee-industry will be successfully established. The importation of bees, however, attended as it is with the danger of introducing serious diseases, is again a matter which can only be accomplished by careful and accurate work, and should not be attempted except under scientific control.

ANNUAL REPORT OF THE AGRICULTURIST FOR 1923.

By F. G. Spring.

The Agriculturist (Mr. Spring) was in charge of this section of the Department throughout the year.

The Assistant Agriculturist (Mr. E. Farquharson) was in immediate charge of Kuala Lumpur Experimental Plantation, the Public Gardens, and the grounds around Government House, Carcosa, and the Sultan of Perak's Lodge, Kuala Lumpur. This officer also assisted the Agriculturist generally at headquarters.

Mr. E. Mathieu, Superintendent, Government Plantation, Kuala Kangsar, went to Europe on the 20th June, 1923, and on this date Captain Howlett took over charge of Kuala Kangsar Plantation. Mr. Mathieu returned from leave on the 26th December, 1923, and was reappointed Superintendent.

Experimental Plantations.

The following shows the expenditure and receipts from the Experimental Plantations Kuala Lumpur and Kuala Kangsar during the year.

Total upkeep expenditure, Experimental Plantation Kuala Lumpur ...	\$18,996.25
Total upkeep expenditure, Experimental Plantation Kuala Kangsar ...	5,853.53
Receipts of rubber sold ...	4,014.72
,, ,, plants and seeds sold ...	2,518.54
,, ,, total produce ...	6,533.26

The amount of rubber, in store, at the close of the year was approximately 10,440 lbs.

All buildings were maintained in thorough repair, whilst roads, and drains, were kept in good order.

General Information.

In my report of last year reference was made to the interest shown by residents in crops other than established products, namely rubber and coconuts. This interest has not only continued but has increased considerably.

The following is a statement showing the subjects on which information was asked for and given :—

Agricultural Crops.—African oil Palm, Arghan fibre, Banana, Castor oil plant, Chaulmoogra oil, Coffee, Corn, Cotton, Fureraea fibre, Gambier, Groundnuts, Ipecacuanha, Jute, Kapok, Kola nut, Manila hemp, Maize, Nipah Palm, Pepper, Ramie fibre, Red Jersey Potato, Roselle fibre, Sago palm, Shea nut, Sisal hemp, Soya bean Tapioca, Tea, Tobacco, Tuba Root, Vanilla, and Vegetable Dyes.

Fruit Culture.—Banana, Papaya, Passion fruit, Pineapple and fruit culture generally.

Grasses.—Australian, Bermuda, Citronella and Guinea grass.

Cover Crops.—Leucaena glauca, Mimosa invisa, Tephrosia candida and Vigna oligosperma.

General.—Bud-grafting, Dairy farming, Methods for the prevention of soil wash, Poultry, Shade trees and Vegetables.

There was a large and constant demand for planting material and the Department was in a position to meet the majority of the applications, but instances where it was not possible to do so addresses of a suitable source of supply were given.

British Empire Exhibition.—Members of the Division devoted considerable attention to the preparation of specimens for the British Empire Exhibition, and to the writing of articles on Agriculture for the Handbook to be produced in connection with the exhibition.

Visit to Estates.—Several visits were made to estates to advise on the growing of various economic products and agricultural matters in general.

A list of growers of crops in the Peninsula, other than rubber and coconuts, was made on behalf of the Chief Agricultural Inspector F. M. S. for distribution to the Assistant Inspectors of the various states.

The Agriculturist acted on a committee for the management of the Batu Caves Tamil Settlement and was Honorary Secretary of the Gardens Committee during the year.

The Government plantations at Kuala Lumpur and Kuala Kangsar and the grounds around Government House, Carcosa and the Sultan of Perak's Lodge, Kuala Lumpur, were maintained in good order throughout the year.

Rubber.

Records of an experiment, to compare the yield obtained from individual trees of various ages, were kept.

Demonstrations on Bud-grafting of Hevea were held at Rantau, Banting, Malacca, Tebrau Estate, Kuala Selangor, Bukit Cheraka Estate, Jeram, and several at headquarters. Several estates were visited in connection with bud-grafting.

A lecture was given at Atherton Estate on "Drainage, Tillage and Green Manuring of rubber areas".

Several estates were visited to advise on replanting programmes.

Cover Crops.

Vigna oligosperma is rapidly gaining favour as a cover plant and during the second half of the year many applications were received for planting material. Seed of this legume is difficult to obtain and it is recommended to establish the cover by cuttings. Cuttings can only be had in limited quantities and it is advisable therefore to plant cuttings in nursery bed, under the best possible soil conditions, in order that a stock may be quickly raised for planting out in the field.

It has been reported that Giant mimosa (*Mimosa invisa*) on some estates commences to die back after it has been in the field for a period varying from 1½ to 2 years. The plants die back in patches, at first, but later larger areas are effected. *Centrosema Plumieri* remains a popular cover crop, but as mentioned in previous reports it only thrives well under good soil conditions.

Prevention of Soil Wash.

This has been dealt with in previons annual reports but I would again like to draw attention to the necessity of doing everything possible to prevent, or at least reduce, surface erosion. The surface layer is generally rich in humus and available plant food, consequently denudation is responsible for a reduction in fertility and of deterioration of the texture of the soil.

Fruit Culture.

Article on the cultivation of oranges, and of Avocado pears in this country were published in the Malayan Agricultural Journal.

Considerable success has been attained by the Department in the growing of the Avocado pear on the plains and there is every reason to believe that it will thrive on the hills. A good stock of seedlings has been raised for distribution. Melon seed were received from Siam and an experiment is being conducted to enquire if this fruit can be grown locally. It would appear that the season of harvesting is an important factor. Several Brazil nut trees yielded an excellent crop of nuts and it can now be definitely recorded that the tree is well adapted to local conditions. A number of Brazil nut seedlings were supplied to various applicants and a large number of seeds have been planted to provide material for future distribution. Plants of a good variety of lemon were raised by marcottage

A visit was made to Teluk Datoh with a view to planting up a collection of fruits in the grounds surrounding the Rest House. A scheme was prepared and the work completed by the end of the year.

Assistance was given to prospective fruit growers as regards methods of cultivation and the supply of planting material. A large quantity of seedlings which were somewhat large for the nursery were given free of charge to the Railway Department, F.M.S. and the occupants of the Chinese Agricultural Settlement.

A visit was made to Carey Island in connection with the marcotting of oranges and lemons.

A list of all persons supplied with fruit seedlings has been prepared and the Department is keeping in touch with growers.

Peas and Beans.

An endeavour is being made by the officers of the Department to encourage a local production of pulses, especially by Chinese market gardeners.

A good deal of attention has been given to the Soya bean (*Glycine Hispida*) which is a valuable food crop. It is a native of China and Japan where it has been cultivated for food from time immemorial. It is also a favourite food amongst Tamils. This bean has bean grown, in Malaya, from time to time, with varying degrees of success and it was considered that good returns could not be obtained unless a particular type was imported or a variety acclimatized to local conditions. A visit was made by Mr. Spring to Manchis, Pahang, as it was reported that the bean was being cultivated in that neighbourhood. It was found that upwards of 30 Chinese small holders are growing Soya beans successfully. A report on the subject has been prepared for publication in the Malayan Agricultural Journal. Seed obtained from Manchis has been planted at Kuala Lumpur, Kuala Kangsar and Serdang Experimental Plantations, and a trial is also being made at Tanjong Rambutan.

The growing of Lima Beans (*Phaseolus lunatus*) has been taken up by numerous planters and others and in several instances satisfactory reports have been received from the growers on the results obtained. Thirty eight applicants were supplied with seed. The Lima Bean is a favourite food with those familiar with it and deserves to be more generally cultivated. Very excellent yield have been obtained from the Lima Bean locally.

Tuba Root (Derris Sp.).

A quantity of Tuba Root was forwarded to the United States Department of Agriculture, Porto Rico, for experimental purposes. At the request of the Imperial Institute, London, a list of local suppliers of this product was forwarded to the Institute. Powder was

prepared from the roots and stems of two varieties of Derris and handed over to the Government Entomologist for experimental purposes. Several reports on the value of Derris as an insecticide were received from Australia.

TOBACCO.

Reports on tobacco leaf grown at Kuala Kangsar Government Plantation were received from two local firms.

A sample of tobacco grown at Kuala Kangsar was submitted to the Agricultural Chemist for a report on the nicotine content of the leaf. The report states that this variety of tobacco contains over 5% of nicotine in the sun-dried leaves and that the species show great promise as an insecticide and compares very favourably with Nicotiana Rustica. The Agriculturist visited several cigar manufacturers in Kuala Lumpur who import leaf from Burmah and Sumatra and make the cigars in this country. It would appear that there is a considerable demand for tobacco leaf here, and the manufacturers are prepared to purchase locally grown tobacco.

GROUNDNUTS.

Three estates were visited to advise on the cultivation of this crop. Figures have been obtained in respect of yields, percentage of oil, and cake, prices and costs of production from groundnuts grown on a commercial scale in this country. There is a very large importation of groundnut oil into the Peninsula and local growers should find a ready market for the oil and the nuts.

ROSELLE FIBRE (HIBISCUS SABDARIFFA VAR. ALTISSIMA.)

The sale of Roselle ropes from one estate in Perak amounted to 7235 lbs. and the prices obtained by the estate were:—¾ inch in diameter and upwards 20 cents a lb. and ¼ inch or less in diameter 45 cents a lb. The ropes found a ready market.

Samples of Roselle fibre and ropes were sent to Raffles Museum, Singapore, and to the Malay States Information Agency, London, for exhibit.

KAPOK (ERIODENDRON ANFRACTUOSUM.)

A stock of plants was raised from seed obtained from good yielding trees at Kuala Kangsar.

BEE-KEEPING.

A hive of the type suitable for *Apis indica* together with accessories was ordered and received from Ceylon. Two copies of the hive were made and it is proposed to carry out experiments on Bee-keeping at Kuala Lumpur and Kuala Kangsar Experimental Plantations.

General.

A visit was made to the experimental farm attached to the Central Mental Hospital, Tanjong Rambutan. A good deal of planting material has been supplied by the Department of Agriculture for experimental purposes there. Experiments are being conducted at Tanjóng Rambutan with the following :—fruits, vegetables, oil producing plants, fodder grasses and stock. The Department imported two pure bred Poland China boars from the Philippines for crossing with local stock ; the results obtained are highly satisfactory.

ANNUAL REPORT OF THE AGRICULTURIST, GOVERNMENT PLANTATIONS, FOR 1923.

By B. Bunting.

Staff.

Mr. B. Bunting, Agriculturist, was responsible for the administration of the Government Plantations; Pondok Tanjong, Kuala Tembeling, Castleton Estate, Telok Anson, the Experimental Coconut Plantation, Sapintas, and the Experimental Plantation, Serdang throughout the year and was assisted by Messrs. J. N. Milsum, T. D. Marsh and E. A. Curtler, Assistant Agriculturists and J. Lambourne, Superintendent, Government Plantations.

Mr. J. Lambourne returned from leave and assumed duty at the Experimental Plantation, Serdang on the 7th July, 1923.

Mr. J. N. Milsum proceeded on leave on the 2nd August, 1923 and Mr. J. Lambourne was appointed to act as an Assistant Agriculturist as from that date.

Expenditure and Revenue.

The following shows the expenditure and revenue, both estimated and actual, of the Government Plantations, Pondok Tanjong, Kuala Tembeling, Castleton Estate, Telok Anson, the Experimental Coconut Plantation, Sapintas, and the Experimental Plantation, Serdang, during the year under review.

Expenditure.

	Estimated.	Actual.
Government Plantation, Pondok Tanjong	$ 30,950.00	$ 30,246.38
,, ,, Kuala Tembeling	24,000.00	15,508.68
Castleton Estate, Telok Anson ...	32,000.00	23,198.51
Experimental Plantation, Sapintas ...	54,520.00	15,302.44
,, ,, Serdang ...	87,500.00	86,280.11
Totals ...	$228,970.00	$200,536.12

Revenue.

	Estimated.	Actual.
Government Plantation, Pondok Tanjong	$ 26,250.00	$ 39,520.63
,, ,, Kuala Tembling	200.00	252.90
Castleton Estate, Telok Anson ...	35,500.00	39,219.82
Experimental Plantation, Sapintas ...	7,500.00	8,499.98
,, ,, Serdang ...	1,000.00	849.26
Totals ...	$ 70,450.00	$ 88,342.59

The total expenditure for the above Government Plantations for the year was $200,536.12 against $236,535.36 in 1922, which is a further reduction in expenditure of $35,999.24, whilst the total revenue for the year was $88,342.59 against $64,813.93 in 1922, or an increase in revenue of $23,528.66.

The reduction in expenditure is due partly to the cessation of development work on plantations other than that at Serdang, which is devoted entirely to crops other than Rubber and Coconuts, and partly to the lower cost of materials during the period under review.

The large increase in revenue is entirely due to the better prices realised from the sale of rubber brought about by the general restriction of output under Government control.

Government Plantation, Pondok Tanjong.

Mr. F. M. McCormac was in charge of this plantation throughout the year.

The area of the plantation is approximately 607 acres, which is made us as follows:-

Mature Rubber	...	293	acres.
New Clearings	...	300	,,
Building sites	...	7½	,,
Waste land	...	6½	,,

Owing to the necessity for curtailing expenditure all development work on the New Clearings (unplanted) was suspended and at the close of the year arrangements were well in hand for the disposal of this area by Public Auction at the Land Office, Taiping at a reserve price of $30,000/-, which amount was the valuation of the land and buildings thereon at the close of the current financial year.

The planted area has been further improved by thinning out a number of untappable trees. All drains have been cleaned out and bridges repaired where necessary, so that the whole area is now in a very satisfactory condition.

The cost of weeding the mature area was 2.84 cts. per acre per month, which gives a figure of $3.41 per acre per annum, against $2.70 for the previous year. The slight increase in cost was brought about by cleaning up the low-lying area, liable to flooding. The weeding of the new clearings cost approximately 39 cts. per acre per month.

The labour force at the end of the year comprised 59 males and 28 females and 7 minors or a total of 94 Tamil coolies, which is considered sufficient for all requirements. The average daily check-roll wages throughout the year was 39.55 cts. per coolie.

The general health of the labour force has shown slight improvement during the year and a notable decrease in the number of malarial cases has been observed. There were 139 admissions to hospital and no deaths during the year.

All buildings have been maintained in good repair throughout the year.

The whole of the planted area (298 acres) is in bearing and, with the exception of two small areas tapped on a third or alternate days, the system of tapping is one cut on a quarter alternate day.

At the present time there are 17,394 trees being tapped and the number of tapping tasks is 52½. The average bark consumption was under ¾ of an inch per month and cases of wounding were practically reduced to a minimum As might be expected under such a conservative system of tapping, the bark renewal has shown great improvement.

An output of 79,237 lbs. of dry rubber was obtained during the year, which was tapped and collected at a cost of 5.14 cts. per lb. The "all in" cost for the year was 27.80 cts. per lb. against 19.92 cts. per lb. in 1922. The slight increase in cost of production is due to the lower crop harvested under restriction during the period under review.

Out of 12 consignments of rubber despatched to the Singapore Auctions during the year nine were awarded the Singapore Standard price for Smoked Sheet. The average price realised throughout the year was 19.80 cts per lb.

As will be seen from the statistics given at the beginning of this report the excess of revenue over expenditure for the year was actually $9,217.25.

The result of the tapping experiment inaugurated to test the relative value of the alternate day and periodic resting systems of tapping showed that alternate day tapping was in the end slightly superior to periodic tapping as regards both yield of latex and tapping costs.

Diseases and pests are still troublesome, but every effort is being made to keep them under control. *Ustulina zonata* and *Fomes lignosus* are the most prevalent diseases, whilst a large number of trees are subject to Brown Bast. Pink disease (*Corticium salmonicolor*), Patch Canker and Wet Rot (*Fomes pseudo-ferreus*) are also present, but to a less extent than formerly.

White Ants (*Coptotermes gestroi*) continue to give trouble, but appear to be kept well in check.

Rain was recorded on 209 days during the year giving a total rainfall of 127.69 inches.

Government Plantation, Kuala Tembiling.

Capt. F. J. Ayris remained in charge of the plantation throughout the year.

The area of the plantation is approximately 854½ acres, which is made up as follows:—

Mature Rubber	... 325	acres.
Immature Rubber	... 126	"
Cleared but not planted	... 11	"
Building sites	... 9	"
Reserve land	... 383½	"

As a result of the curtailment of expenditure the general appearance of the plantation is not quite so good as it was at the end of 1922, it is however, in good condition and the best has been done with the money available.

A large portion of the mature area is planted with *Centrosema Plumieri* and *Dolichos Hosei* and the balance clean weeded. Both these leguminous cover crops do well on this particular type of land, but, owing to the dense shade now produced, the Centrosema is gradually dying out in the older fields. The Centrosema in the immature area is doing well, but is not sufficient to keep down weeds.

The average cost of weeding the mature area (part clean weeded) was $1.01 per acre and that of the immature area (part strip weeded) $2.14 per acre per month respectively. The cost of weeding the immature area shows a considerable reduction on the figures for last year and with the increased shade now being produced a further reduction may be expected next year.

Owing to the necessity of cutting down expenditure, roads, drains and bridges have only been maintained in fair condition throughout the year.

The labour force at the end of the year consisted of 38 males, 13 females and 2 minors or a total of 53 Tamil coolies.

The general health of the labour force has on the whole improved. There were 36 admissions to hospital and no deaths during the year.

Although little or no expenditure has been incurred on buildings during the year, they are all in fair condition and the few minor repairs required will be carried out early in 1924.

Diseases and pests were kept fairly well under control. Pink disease is less prevalent than formerly, but still gives a certain amount of trouble. Isolated cases of *Fomes lignosus* have been recorded and infected trees are treated immediately they are found in order to prevent further spread of this virulent disease. White ants give

practically no trouble and attacks from this pest are very rare. Deer were very troublesome early in the year and did a small amount of damage, but no further visits of this pest have been reported.

Rain was recorded on 182 days during the year, giving a total rainfall of 86.96 inches.

Castleton Estate, Telok Anson.

Mr. T. D. Marsh, Assistant Agriculturist, was in charge of this estate throughout the year.

The area of the estate is approximately 208 acres, which is made up as follows :—

Mature Rubber	...	197 acres.
Coconuts	...	6½ ,,
Building sites	...	4½ ,,

The area under rubber is kept in a clean weeded condition, but that under coconuts is planted up with various catchcrops from time to time. The average cost of weeding was 22.16 cts. per acre per month, which gives a figure of \$2.66 per acre per annum against \$2.44 for the previous year.

The labour force at the close of the year consisted of 79 Tamils—58 males, 16 females and 5 minors- and 2 others, or a total of 81 coolies. The average daily check-roll wages throughout the year was 39.59 cts. per coolie.

The health of the labour force is very satisfactory. There were 6 admissions to hospital and 2 deaths, one the result of a railway accident, during the year.

Numerous repairs to both coolie lines and bungalows have been carried out during the year and all buildings are now in excellent condition throughout.

The whole of the area planted with rubber is in bearing and, apart, from a number of experimental plots, the system of tapping is one cut on the quarter daily. The total number of trees at the close of the year was 15,807 or an average stand of about 75 trees per acre.

The amount of dry rubber harvested during the year was 83,437 lbs., which is equivalent to an average yield of 423 lbs. per acre per annum. The average cost of tapping and collecting was 7.49 cts. per lb. against 7.42 cts. per lb. in 1922. The somewhat high cost is due to the large area under experiment, which limits the number of trees tapped per coolie.

The " all in " cost of production was 28.50 cts. per lb. as against 29.08 cts. in 1922. This figure includes all experimental

tapping, which is responsible for a considerable increase in working costs. The whole of the rubber was sold at the Singopore Auctions and the average price realised throughout the year was 46.83 cts. per lb., which was quite good, considering the large proportion of experimental rubber.

The various experiments on different systems of tapping, individual yield of trees, early and late tapping, various methods of cultivation, and the effects of thinning-out on yield of rubber were continued throughout the year. Some of these experiments are nearing completion and the final results will be published in due course in the Malayan Agricultural Journal.

The small area under Coconuts is very irregular in growth, but some of the palms are now producing nuts. A large number of the palms were used for inoculation experiments with Bud-rot with the result that many of them were either killed off or had to be removed owing to abortive growths.

Numerous small plots of minor economic crops were interplanted amongst the coconuts and fairly good results were obtained with dry land padi.

Diseases and pests continue to be kept well under control, but Brown Bast still gives trouble and there is little doubt that this is due to the previous heavy system of tapping carried out on this estate. Isolated cases of *Sphaerostilbe repens*, Die back (*Diplodia* sp) are to be found, whilst occasional attacks of both White Ants and Borers (*Platypus lepidus*) have been reported, but these pests do little or no damage.

Rain fell on 155 days during the year, giving a total rainfall of 102.92 inches against 90.10 inches in 1922.

Experimental Coconut Plantation, Sapintas.

Mr. F. G. Parkin was in charge of this plantation until the 3rd April, when he proceeded on long leave. Mr. M. R. Hartley took over from Mr. Parkin and continued to act as Manager until the 29th July, when he resigned the appointment. Mr. R. R. Hartley was then appointed to act as Manager and remained in charge at the end of the year.

The area of the plantation is 2,122½ acres, which is made up as follows:—

Coconuts	...	938.1	acres
Rubber	...	88.6	,,
Cleared but not all planted	...	64.3	,,
Felled and part cleared	...	57.1	,,
Building sites	...	17.3	,,
Waste land	...	45.5	,,
Reserve jungle	...	901.6	,,

The general improvement of the appearance and growth of both the mature and immature coconut areas has continued, which is most satisfactory. Of the young areas of coconuts (tall variety) planted October-November, 1919 a census taken in July showed that a small number of palms were actually in bearing, whilst a large number had reached the flowering stage. The same applies to the areas of Dwarf or King Coconuts planted in September–December, 1920, a year later.

Owing to the curtailment of expenditure, all development work was suspended and, with the exception of supplying a number of vacancies, no planting was done during the year under review.

The area under rubber has continued to show considerable improvement in growth in both the old and the young areas. A census of trees taken in July showed that there were 4,370 of a tappable size, against 3,360 at the same date last year.

Of the area planted with coconuts approximately 245 acres were clean weeded, 200 acres under Giant Mimosa (*Mimosa invisa*), 92 acres under experimental covers, 28 acres under sweet potato (*Ipomea Batatas*) and 425 acres under grass weeding. In every case the best growth has been shown on the clean weeded areas and on this type of land, which is a very stiff clay, the young palms are much more developed than those in the areas planted with leguminous cover-crops.

The whole of the rubber area is still under Giant mimosa, but, owing to the increased shade produced by the older trees, the growth of the cover is somewhat restricted and in parts it is gradually disappearing altogether.

The average cost of weeding the whole of the coconut area was $1 01 per acre per month against $1.64 per acre per month for the previous year. The average cost of weeding the rubber area was 90 cts. per acre per month against $1.03 per acre in 1922. The heavy nature of the soil is responsible for the comparatively high costs of weeding on this particular plantation.

Lalang is still troublesome in the areas under grass weeding, but is kept fairly well under control.

The experiments with various leguminous and non-leguminous cover crops were continued and the following cover crops were under trial at the close of the year:—*Centrosema Plumieri*, *Mimosa invisa*, *Clitoria cajanifolia*, *Doliches Hosei*, *Tephrosia candida*, *Tephrosia Hookeriana*, *Bassiflora foetida* (Passion flower) and *Ipomaea Datatas* (Sweet potato). The area under experiment, including 4 clean weeded controls, was approximately 72 acres. General observations on the growth and appearance of the palms under experiment show that the clean weeded plots and those planted with *Tephrosia candida* are well in advance of the other plots with the non-leguminous covers and grass-weeded plots most backward in growth and the foliage quite yellow instead of the usual healthy green appearance shown in the other plots.

A considerable amount of drainage work was carried out during the year, which included the cleaning out and deepening of the 4 ft. drains on an area of about 365 acres. Some of the 4 ft. drains in Fields 15, 16, 17 and 23 were re-cut so as to bring them properly in between the rows of the palms in the experimental blocks laid down to test the effect of different systems of planting. Scupper drains were cut between the rows of palms in Field 1, but the work was not quite completed at the close of the year.

A new watergate is required to replace the one which has collapsed in Fields 3/4 and it is expected that the new gate will be erected early next year. The other two watergates have worked well during the year and given practically no trouble beyond a certain amount of piling at the outlets.

Mounding up of the young coconut palms in the peat area in Fields 8 and 9 was completed during the year. Other mounding work was carried out in various fields, where the palms had not got sufficient hold and, therefore, liable to get blown over by high winds.

Roads and bridges have been repaired where necessary and are now in very good order.

With the exception of the 116 acre selection block, the whole plantation is now practically clean cleared of all timber.

Supplying was carried out in the younger areas and altogether 1494 plants were supplied in the coconut area and 600 stumps in the rubber area.

The labour force at the end of the year consisted of 159 males 51 females and 26 minors, or a total of 237 Tamil coolies. This is hardly sufficient for present requirements and it will be necessary to increase the number of coolies to about 300 by recruiting from India. The average daily check-roll wages throughout the year was 38.05 cts. per coolie.

The general health of the coolies was on the whole satisfactory. There were 266 admissions to hospital and 4 deaths (2 women and 2 children) during the year.

All buildings were maintained in thorough repair, the bungalows being re-oiled and the coolie lines lime-washed during the year.

A crop of 216,217 nuts was harvested during the year as against 120,608 in 1922. Of the crop harvested 215,221 nuts were made into copra, producing 838.59 piculs, which was sold at an average price of $10.66 per picul. The balance of 996 nuts were sold to coolies at an average price of 3.49 cts. each.

The average cost of harvesting and making the copra was $1.02 per picul and it took an average of approximately 257 nuts to produce a picul of copra.

The total amount realised for the sale of nuts and copra was $8,939.48 against $4,130.90 for the previous year.

A census of the coconut palms taken in July showed that there were 7,343 palms in bearing and a further 2,072 palms flowering in Fields 1 to 12 (895.4 acres) which is roughly 50% of the palms in bearing on this area. In addition to this there were approximately 3,000 palms flowering on the young areas which were only planted in December, 1919 (tall variety) and December 1920 (dwarf variety).

Diseases and pests on the coconut area gave a certain amount of trouble. A number of cases of Bud-rot and Transverse leaf-break have occurred and diseased palms have either been treated or cut out and destroyed.

The black beetle (*Oryctes rhinoceros*) has done a certain amount of damage, but considerable numbers have been caught, whilst its larvae have also been collected and destroyed. The "Red-stripe" weevil (*Rhynchophorus schach*) is very seldom found. Grasshoppers (*Valanga nigricornis*) have done considerable damage to young seedlings and in many cases they have killed off the young plants. They were found to be harboured by the Giant mimosa (*Mimosa invisa*) being used as a cover-crop and it was necessary to remove the cover crop completely in order to get rid of this pest. White ants still continue to give trouble, but are kept well under control by the pest gang. Wild pig has also been very troublesome during the past year and a considerable number of young seedlings have been destroyed by this pest.

In the rubber area isolated cases of *Fomes lignosus* are reported occasionally, but on the whole there is very little disease present. White ants are, however, somewhat troublesome in this area, but the pest is systematically treated and kept well in check.

Rain fell on 136 days, giving a total rainfall of 84.28 inches against 78.80 inches in 1922.

EXPERIMENTAL PLANTATION, SERDANG.

This new experimental plantation, which has been started with the object of testing out all crops other than rubber and coconuts, is situated at Serdang in the State of Selangor, and is roughly about 14 miles south of Kuala Lumpur.

The area of the plantation is approximately 1,525 acres, half of which is hilly land and the other half either flat or gently undulating. The former, being less suitable for the experimental work now in progress, has been kept in reserve and only the latter type of land has so for been opened up.

At the close of the year an area of about 400 acres had been clean cleared and planted up with various crops and a further area of 165 acres had been felled, burnt and practically clean-cleared ready for ploughing preparatory to planting up further experimental plots.

The newly opened area, consisting of flat land, is particularly suitable for experiments with annual crops and the major portion of it will be reserved for this purpose.

The block of 10 acres specially reserved for a permanent nursery for the propagation of planting material is very conveniently situated in a central position and on the main road leading through the plantation. The whole area is systematically laid out in 1/10 acre plots which is a most suitable size for carrying out preliminary trials with annual crops, which only occupy the land for a comparatively short time. Good wide roads have been placed through and around this area, which is enclosed on all sides by a thick bamboo fence.

Considerable attention was paid during the year to the introduction of new planting material and, out of 48 new species of plants received, no less than 45 of them were definitely established on the plantation. In addition to this must be included 15 new varieties of groundnuts, 7 varieties of *Derris* (Tuba), 5 high yielding varieties of tapioca, 4 varieties of sweet potatoes and 4 varieties of African oil palm.

A further area of about 120 acres was planted up during the year under review, which included the following crops :—Limes 48½ acres, Coffee 15 acres, Nutmegs 10 acres, Pineapple 9 acres, Annatto 4 acres, Gambier 3 acres, Roselle 2½ acres, Tapioca 2 acres, Vanilla 2 acres and a large number of one acre plots of miscellaneous crops.

The following gives the approximate areas of the principal crops which had been actually planted out at the close of the year :—African oil palm 50 acres, Kapok 50 acres, Limes 48½ acres, Sisal hemp 25 acres, Mauritius hemp 25 acres, Sugar-cane (23 varities) 25 acres, Coffee (7 varieties) 24 acres, Nutmegs 10½ acres, Candle nut 9 acres, Sugar palm 9 acres, Annatto 4½ acres, Manila hemp 4 acres, Papaya (2 varieties) 4 acres, Cloves 8½ acres, Castor oil (3 varieties) 3 acres, Coca (cocaine) 3 acres, Gambier 3 acres, Areca nut 2½ acres, Bananas (approximately 120 varieties) 2 acres, Purging nut 2 acres, Roselle fibre 2 acres, Tapioca (2 varieties) 2 acres, Vanilla 2 acres, Arrowroot, Cocoa, Gingelly, Sea Island cotton, Ramie fibre, Bowstring hemp, Lemon grass, Citronella grass, Vetiver grass, Guinea grass, Rhodes grass, Natal red top grass, Dallis grass, Carpet grass, Napier grass and Merker grass 1 acre each.

In addition to the above areas must be included the permanent nursery of 10 acres fully planted and also a large number of small plots of less than 1 acre.

The nurseries are well stocked with seedlings of various crops which will be required to plant up the new 165 acre block now being opened up.

A large quantity of planting material was forwarded to headquarters for distribution throughout the country and included seeds of Fibre plants, Food crops, Oil-producing plants and numerous Cover crops.

As previously reported an area of 50 acres has been reserved for an arboretum and this is gradually being planted up with small groups of trees and shrubs which are likely to prove of economic value later, when they will be planted out on a field scale in the same way as other crops of known value.

A few new drains have been cut where necessary, whilst existing drains have been cleaned out and deepened with the result that whole of the drainage system is working very satisfactorily. In the ravines a number of foot-hill drains have been put in to collect and drain off seepage purely as an anti-malarial measure. A regular system of silt-pitting was carried out on most of the high land, whilst two small areas of steep land were terraced and citronella grass planted on the contour. These precautions have been taken in order to prevent soil wash as far as possible.

A strong barbed wire fence has been erected along the northern and eastern boundaries of the new clearings and continued on to the arboretum thus practically enclosing the whole of the lower area of the plantation.

Considerable progress was made in the construction of connecting roads on the plantation and these are covered with laterite as transport is available for carrying out this work. These roads have been properly drained and on the higher levels a row of citronella grass has been planted on each side of the road to prevent possible damage from soil wash.

The Public Works Department commenced work at the end of the year on the construction of the new approach road to the plantation and it is expected to complete this road early in 1924. This new entrance road will be a considerable improvement on the existing road as in addition to being much shorter, it is practically on the level the whole way and will therefore do away with the somewhat heavy gradients which are encountered at present.

With the exception of about 40 Tamils, who reside on the plantation, the labour force is composed of non-resident Chinese coolies engaged locally from day to day. So far the employment of casual Chinese labour has been fairly satisfactory, but with the present increase in the opened area it is considered advisable to employ a number of Tamil coolies who will be resident on the plantation and thus form the nucleus of a permanent labour force. The average number of coolies employed daily throughout the year was 334 and the rate of pay averaged 43.68 cts. per diem.

Although isolated cases of malaria occurred from time to time, the general health of the labour force was fairly good, there being only 16 admissions to Hospital and no deaths during the year.

The following new buildings were erected on the plantation during the year:—

2 Bungalows for Assistant Agriculturists.

1 Single Garage for Bungalow No. 1.

1 Double „ the Hostel.

3 Quarters for Clerk and Overseers.

1 Set Cooly Lines of 12 rooms.

1 „ „ 20 „

1 Set Kitchens of 4 rooms.

1 „ „ 5 „

1 General Store with office.

1 Cattle Shed of 3 stalls.

1 Dark Room for Photography.

1 Temporary Attap Shed for Chinese Oil Presses.

All existing buildings have been maintained in good repair throughout the year at very little cost.

The loan of 12 Decauville trucks and about half a mile of track was obtained from the F.M.S. Railway for filling in of a permanent site for Factory and Store buildings and good progress was made on this work during the latter half of the year.

As might be expected with such a large number of crops under cultivation, considerable attention has to be paid to the control of diseases and pests. The fact that the whole area has been absolutely clean-cleared of all timber is probably partly responsible for reducing the infection of disease in many of the crops now under cultivation and so far no serious damage has been reported under this heading. The same cannot, however, be said of pests and the ravages of certain insects have caused considerable trouble with the majority of the crops necessitating the employment of both preventative and remedial measures to keep them under control.

At the present time insect pests are so troublesome on some of the crops that the cost of controlling them will probably be the limiting factor against their successful cultivation from an economic standpoint.

The collection of botanical specimens of economic plants for the herbarium has been continued and a number of new plants has been added to the collection during the year.

The average maximum temperature recorded during the year was 92.32° F. and the average minimum temperature 74.64° F., the

highest maximum being 98° F. in April and the lowest minimum 64° F. in February.

Rain fell on 181 days during the year, giving a total rainfall of 81.94 inches.

A large number of visitors were shown round the plantation during the year which naturally occupied the time of the staff to a considerable extent and, as the scope of the plantation increases, it will be necessary to make provision for this contingency.

Official visits were paid during the year by H. E. the High Commissioner (Sir Laurence N. Guillemard, K.C.B., K.C.M.G.) on the 14th February, the Acting Chief Secretary (The Hon'ble Mr. E. S. Hose, C.M.G.) on the 4th June, the Members of the Advisory Committee on the 16th October and the Chief Secretary (The Hon'ble Mr. W. George Maxwell, C.M.G.) on the 5th December.

General.

A further course of lectures in the elementary principles of Agriculture was given to a number of Malay Probationers attached to the Department.

A considerable amount of time was taken up in the preparation of exhibits for the forthcoming British Empire Exhibition and to a certain extent this disorganised the normal work of the Division during the period under review. In addition, a large number of articles in connection with the cultivation of various economic crops was contributed to the Handbook of Malayan Agriculture which is being specially prepared for the above Exhibition.

ANNUAL REPORT OF THE AGRICULTURE, INSTRUCTOR, FOR 1923.

By D. H. Grist.

1. Staff.

The writer continued in charge of the Division for the period under review.

Captain J. M. Howlett, M. C., was transferred to Kuala Kangsar as Agricultural Instructor, Perak on January 21st. From June 18th till Decembr 21st he fulfilled the additional duties of Superintendent Government Plantation, Kuala Kangsar.

2. School Gardening.

The school garden scheme, initiated by the Division towards the end of 1922, has made satisfactory progress. Such difficulties as have arisen have been overcome by means of frequent visits to all schools on the register of school gardens; by the regular publication of articles on the subject in the Malay Agricultural Bulletin of the Department; by a special course of lectures in the Malay language to teachers at the Tanjong Malim College; and at all times, by the loyal co-operation of the Inspectors of Schools.

A preliminary visit was made to thirty-three school gardens in Perak, as a result of which it was decided to register eighteen schools in the State as being under the supervision of the Division. These schools have shewn improvement during the year.

At the end of the year under review, the following school gardens had been included on the register of the Division.

State.		No. of School Gardens.
Selangor	...	14
Pahang	...	10
Negri Sembilan	...	22
Perak	...	18
Total	...	64

as against eight at the end of 1922.

The above is not a complete list of schools in which gardening is included in the curriculum. There are many more in Perak, and the work has been started at the other schools in Negri Sembilan, Pahang and Malacca.

Owing to the large number of "unofficial" school gardens that have been started, and the liability of further supervision by the Instruction Division, arrangements have been made to issue a circular letter stating that the Division will assist all such schools by advice and planting material, and, if especially requested, by a personal visit There has been considerable response from the gurus.

3. Agricultural Shows and Exhibitions.

A revival of interest in agricultural shows and exhibitions resulted from the Malaya Borneo Exhibition in 1922, and an organization (The Malayan Agri-Horticultural Association) has done good work to bring to public notice the beneficial effects of such events. The Instruction Division has been closely connected with the work of this Association, and by combining the interests of the Department of Agriculture with the objects of the Association, has been able to work towards a closer union of the Department with the agricultural shows. The central idea has been that such shows should be educational by shewing the improvement possible in stock by breeding, selection and suitable feeding; and, by including an organized local industries section, to aim towards making the annual show an "annual fair" for the disposal of the much neglected but valuable arts and crafts which in the past were a feature of Malay "kampong" life.

In a memorandum on the subject of agricultural shows it was suggested that all local shows should be held under the auspices of the Malayan Agri-Horticultural Association. The suggestion has been accepted in many cases, with the result of decreasing the cost of such events and improving their organization by making full use of the experience of the standing committee of the Association.

The financial assistance of Government has been of great service to the organizers of agricultural shows, but it is probable that the shows will tend to become self-supporting as the organization improves.

The Malayan Agri-Horticultural Association held its first Malayan Agri-Horticultural Show and Trade Exhibition at Kuala Lumpur on June 30—July 2nd. About 25,000 people visited the show. Apart from agricultural, horticultural, poultry, livestock, local industries, and dog shows, with a trade section, the following Government departments staged special exhibits which proved to be, not only an attraction to the Show, but of considerable value, as publicity, to the departments concerned: viz. Department of Agriculture, Forestry Department, Malaria Advisory Board, Infant Welfare Committee, the Public Health Authority and the Geological Department.

District Shows have been held as under:—

Pahang: Temerloh, Kuala Lipis, Raub (for the districts of Raub and Bentong), Pekan, Kuantan.

Negri Sembilan: Seremban, Rantau (for Rantau and Port Dickson), Jelubu, Kuala Pilah, Rembau (for Tampin District and the sub-district of Rembau).

Perak: Tanjong Malim (for the districts of Ulu Selangor and Tapah), Upper Perak.

An agricultural show was also held in Kedah.

The total number of agricultural shows was therefore fourteen. The Instruction Division give assistance at most of these events, in compiling schedules and stationary, and seeing printing through the press; and assisting in staging and judging the exhibits.

The writor was Honorary Organizing Secretary and Treasurer of the Malayan Agri-Horticultural Association throughout the year.

The Agricultural Instructor served on The Agricultural Sectional Committee (Malaya) for the British Empire Exhibition 1924; and on sub-committees of Finance and Publications in this connection. The latter Sub-Committee have been engaged in editing a second edition of the Handbook of Malayan Agriculture.

4. Publications.

The main work of publications has been an agricultural bulletin in the Malay language, with the title of "Warta Perusahaan Tanah." This was started by the Division at the end of 1922, when the first number appeared. Since then the circulation has increased by 500 copies to 3,000 copies per issue. Four quarterly numbers have been published during the present year. The contents of these numbers was as follows.

Vol. 1	No. 2	...	Editorial. Rubber Restriction. School Gardening. Imports and Exports of Malaya —a discussion of the agricultural possibilities of the country. The Sultan Idris Training College. Tanjong Malim (with illustration.)
Vol. 1	No. 3	...	Editorial. Difficulties of Padi Planters. Co-operation. School Gardening.
Vol. 1	No. 4	...	Editorial. Kapok (with illustration). Co-operation. School Gardening.
Vol. 1	No. 5	...	Editorial. School Gardening. Tobacco cultivation. Co-operation. Note on care of fruit trees.

At the request of the Controller of Rubber Exports, F.M.S. and S.S., a reprint of 5000 copies of the article on Rubber Restriction was supplied to his office.

The writer acknowledges the assistance of the Co-operative Department, and the Dato Penghulu of Rembau for preparing the articles on Co-operation.

The publication of Warta Perusahaan Tanah resulted in increased correspondence with Malay cultivators throughout the Peninsula. About fifty such letters were dealt with, including requests for information on padi, padi pests, tobacco, cotton, roselle and areca nut cultivation, and enquiry for planting material and previous publications of the Department.

Over one thousand copies of the old series of Malay Publications of the Department, dealing with special agricultural subjects, have been distributed during the year, mostly by special requests for copies, but a few at agricultural shows.

Other publications of the Division during the year are as follows :—

Kapok : Malayan Agricultural Journal Vol. XI, No. 1.

Annual Report of Instruction Division 1922" " Vol. XI, No.

Previous examination papers set under the Scheme for Malay Officers of the Department of Agriculture.

5. Kapok.

In continuation of the work of the Instruction Division in 1922, efforts were made in the year under review to interest European enterprise in the purchese and grading of local kapok, and to stimulate Malays and others to give the existing trees more care. As matters stood, a large proportion of the kapok on the banks of the Perak River,—the chief source of supply—was not harvested, as the Chinese price for kapok was considered too low, unless the owner was in debt to the Kapok purchaser. A European interested in this crop undertook to purchase uncleaned kapok. The favourable price offered by this gentleman resulted in a larger crop being harvested. Absence of cleaning machinery and competition from the Chinese buyers, who then bought at higher prices and sold at lower prices, closed the season's work, which, while not a success, from the buyer's point of view yet resulted in renewed interest in the crop on account of the better prices obtained. As it was 50 piculs of kapok was bought in three days.

Propaganda work in English and Malay stimulated increased planting, and there is a demand from several European planters for seed from the next crop in 1924.

This Division suggested a scheme for purchasing kapok from the 1924 harvest, in order that interest in the crop may be sustained. It is the aim of the Division to educate the Malays to harvest and market their crop by co-operative effort.

6. Fibres and other Crops.

The demand for roselle fibre seed for planting on a small scale in "kampongs" and school gardens continued throughout the year, and has been fostered by the Division. Several failures in germination and growth are reported. The planting of this crop needs very careful consideration as to season and soil conditions, and further investigations are necessary. The marketing problem is similar to that of kapok and is receiving consideration by the Division.

The Agricultural Instructor Perak has commenced experiments on the cultivation of *Urena lobata;* Pulut pulut (M)., a way-side weed which is found growing—often under considerable shade—throughout Malaya. It was hoped that areas might be found where the plant was sufficiently plentiful to make collection of wild stems a commercial possibility, but it is now thought that cultivation of the plant will give better results. Stock of fruit trees, and other planting material has been distributed to Malays from Kuala Lumpur and Kuala Kangsar.

7. Educational.

The writer acted as Agricultural Instructor to the Sultan Idris Training College, Tanjong Malim, in addition to his other duties, throughout the year. Two days weekly have been employed at the College. The present courses of lectures and practical work are delivered to nine classes, a total of two hundred students.

The progress made, and the interest taken by the students in this branch of their work at the College, has been an encouraging feature of the course.

A special course of six lectures in Malay, with demonstrations, was delivered at the Sultan Idris College to a vacation class of one hundred vernacular school teachers.

8. Scheme for Malay Officers of the Department of Agriculture.

The arrangement of all courses of lectures and examinations held under this scheme was carried out by the Instruction Division.

The unsatisfactory results obtained under the present scheme of Malay training in the Department has been the subject of much consideration during the year. In the first place it is realised that the

very imperfect knowledge of English which the majority of the Malay officers possess, militates against their progress under the present system. The Agricultural Chemist, Chief Agricultural Inspector and the writer submitted a memorandum on the subject early in the year. Later, a departmental committee was appointed to consider the training of the Malay officers of the Department. In general terms, the two reports agreed that Malay officers on entering the Department should be put through a course of training at a School of Agriculture. A satisfactory course of this description would be followed by service in the Department, where the officer could rise to the post of Senior Agricultural Assistant without further examination. Normally, officers for Prize Appointments should undergo a higher course of training than can be given in a School of Agriculture.

9. Conference of Penghulus, etc.

An endeavour was made to bring the native cultivator, through the Penghulus, more closely in touch with the work of the Department, by meeting individual penghulus in their Mukims when occasion permitted; and also by holding conferences of penghulus in the districts. Conferences between the Division and Penghulus were held at Batu Gajah, Parit, Lambor, Kuala Lipis, Raub and Jelebu.

10. Demonstrations.

Under the scheme of instruction work, as at present constituted, demonstration work is the duty of the Inspection Division. In practice demonstrations are arranged by either Division, or in co-operation.

Penghulus of Seremban District visited the Government Plantation, Serdang in May, and were shewn modern methods of cultivation and planting, and a large number of crops.

Demonstrations of roselle fibre preparation were held at Kapar and Klang by the Assistant Agricultural Inspector Selangor and an officer of the Instruction Division.

With the valuable assistance of the Manager, Triang Estate, a demonstration of roselle fibre preparation was held at the Temerloh Agricultural Show.

The Agricultural Instructor, Perak has given demonstrations of tobacco-growing and curing, roselle-retting, string and rope making, cotton-ginning and kapok-cleaning. Most of these demonstrations have been held on the Government Plantation, Kuala Kangsar.

11. General.

A visit was made to the Perlis Phosphate Caves. Analyses by the Agricultural Chemist of samples collected by the writer shew that

the caves contain a fertilising material of considerable value. It would appear that the present difficulty of the syndicate working these deposites is that of transport. Could this problem be overcome, there are already strong indications that the fertilizer would find a ready market in England and elsewhere.

Visits have been made by officers of the Division to many estates, small holdings and kampongs. By constantly visiting Malay holdings the Division are kept informed of the needs of the native cultivator. The writer served on a Departmental Food Production Committee, which has considered ways and means of increasing the food supply of the country.

ANNUAL REPORT OF THE PLANT PHYSIOLOGIST FOR 1923.

By W. N. C. Belgrave.

The staff of the Division remained unchanged throughout the year.

I have again this year the pleasure of expressing appreciation of the keeness of my Malay Officers.

In February, in addition to my own duties, I took over from Mr. F. de la M. Norris, who proceeded on leave, the supervision of the Departmental Library and the Editorship of the Malayan Agricultural Journal.

In December I took over from Mr. Jago—transferred—the routine duties of Assistant to Secretary for Agriculture and of Accountant.

Work during the year has been almost entirely confined to rubber.

Rubber.

Latex.—The lines of work mentioned in my last annual report were continued, and an account of a portion of this work was published in two articles in the Malayan Agricultural Journal, Vol. XI, No. 12, December 1923; to this periodical further reference should be made for details.

The first article—on coagulation—gave an account of work on the subject, and in it the view was developed that it was unnecessary to postulate an enzyme in latex, and that the phenomena met with in normal latex could be explained by the assumption of a film around the caoutchouc globules, this film being such as is demanded by the theory of surface tension, and containing one (or more) proteins with an iso-electric point at the coagulation point of latex.

The second article—with Mr. R. O. Bishop, Assistant Agricultutural Chemist, dealt with observations on some nitrogenous and other bodies in latex,

Brown Bast.—Throughout the year, general attention has been given to brown bast. An attempt experimentally to produce the affection on a number of trees by very heavy tapping signally failed. It is not improbable that this failure is associated with the fact that the trees were poor in quality and yield, and had been badly over-crowded.

Systems of tapping.—Experiments with girdling cuts (2 Vs) at long intervals (4—5 days) were continued. No injury to the trees under experiment could be detected, nor did the yield diminish to an

excessive extent. At present the system is of scientific interest only, but it is not impossible to imagine circumstances which might render any system which enabled the number of skilled tappers to be reduced to be of great practical value.

The experiment will be continued.

Bud-grafting.—Although no practical work on the problems has been possible, results elsewhere have been followed with interest. A lecture was given under the auspices of the Malacca Planter's Association on July 8th.

The view taken at the lecture was that previously stated in various numbers of the Malayan Agricultural Journal—that bud-grafting, instead of being a proved success as a commercial operation, was on the contrary an experiment, and that a considerable period must elapse before any definite conclusions positive or negative can be drawn; in the meantime it was urged that those who wished to plant bud-grafts should interplant with seed stock, to minimise possible loss.

I was nominated by Government to be a member of a Committee of technical Officers appointed to report on "Certain proposals made to the Government for the formation of a co-operative society of rubber growers to undertake bud-grafting and seed selection of Hevea brasiliensis."

This Committee reported to Government on 25th July.

During the course of the year there was a considerable moderation of the previous optimism as to the success of bud-grafting, and it is not too much to say that 'bud-grafting' *in the form first advocated*, is now regarded with considerable suspicion. Tapping results as far as they have gone, show that it is not the case that any high yielding tree is capable of passing this character on the bud graft off spring; and it is recognised that the raising and tapping of a clone of scions from each selected mother tree is, at present, the only way in which suitable parent trees can be discovered.

OTHER CROPS.

Nipah.—A start was made towards the end of the year in an investigation with Mr. J. H. Dennett, Assistant Agricultural Chemist on the biological problems of the extraction of juice from the Nipah—Palm; this had to be put aside on account of pressure of other work—it was however, found that, at any rate on the plot experimented with, and at the period of year under review, no great difficulty was likely to be met with in controlling changes in the composition of the juice which might be detrimental to alcohol fermentation.

Departmental Library.—The work of registering all publications in the Library was completed, and the compilation of alphabetical indices for Periodicals, Annual Reports and Books started.

Departmental Publications.—The Malayan Agricultural Journal appeared regularly throughout the year—longer articles included :—

Kapok by D. H. Grist.

Rice in Malaya by H. W. Jack.

Production of Alcohol from Nipah Palms by B. J. Eaton and J. H. Dennett.

Factors affecting rate of Vulcanization of Plantation Rubber by R. O. Bishop.

Studies in Hevea Latex :—(1) Coagulation by W. N. C. Belgrave.

Rice in Malaya was subsequently reprinted as Special Bulletin No. 35.

Two Special Bulletins by the Government Entomologist on "The Two-coloured Coconut Leaf Beetle," and "Red Stripe-Weevil," should have appeared, but were delayed by the non-receipt of reproductions of illustrations.

SISAL IN MALAYA.

Information lately received from the Imperial Institute, London ; (Bulletin of Imperial Institute, Vol. XXII, No. 1, 1924) indicates widespread interest throughout the British Empire in sisal hemp.

The Department of Agriculture is keenly alive to the commercial possibilities of the cultivation of this fibre in Malaya and has recently been devoting particular attention to the investigation of this matter.

Details of the work so far carried out in the field and in the factory are being collected for early publication in this Journal.

Samples of fibre grown at the Experimental Plantation, Serdang, and prepared in the Department of Agriculture, have this month been despatched to London for valuation and report.

R.O.B.

1st August, 1924.

ERRATA.

The authors regret the numerous errata which appear. The chief reason was the difficulty attached to the enormous task of reducing the mass of figures to a form suitable for publication. None of the errors invalidate the major features observed during the experiments. The average monthly yield figures and the percentage Brown Bast figures purposely were not worked out accurately, for a small difference in the second decimal place was of no significance in a consideration of the main features.

Page 296 Alt. Daily Full Spiral Total read
2222.78 for 2122.78 lbs.

„ „ „ „ Total x 2 read 4445.56 lbs.

„ „ Line 5 delete systems.

„ 299 „ 11 „ "and in the following analysis are left out of account."

„ 302 Column 6 in first table read per cent. Brown Bast *about.*

„ 306 Total Yields should read 205.75 } Yields for

„ „ Yield per tree per month should read .99 } August.

CORRECTIONS ON PAGES 307, 308 & 309 FOR AV. YIELDS PER TREE.

Page 307	Line	9	read	.99	for	.90
„	„	„	32	„	.43	„	.31
„	„	„	34	„	.86	„	.80
„	„	„	36	„	.57	„	.51
„	„	„	38	„	.80	„	.74
„	308	„	18	„	1.33	„	1.23
„	„	„	30	„	1.35	„	1.71
„	309	„	2	„	1.87	„	1.67
„	310	„	11	„	1.35	„	1.71
„	346	„	35	„	*tens*	„	times.

THE

Malayan Agricultural Journal.

Vol. XII. Sept. & Oct., 1924. Nos. 9 & 10.

FIELD EXPERIMENTS RELATING TO BROWN BAST DISEASE OF *HEVEA BRASILIENSIS*.

By A. Sharples and J. Lambourne.

Introduction.

THE Brown Bast disease of the Para Rubber tree, (*Hevea brasiliensis*) has aroused great interest, even in temperate climates. Doubtless much of the interest was due to the great increase in number of Brown Bast cases observed about 1917, and the obscure nature of the affection has maintained scientific interest since. Locally, numberless articles in more or less popular form have appeared in various periodicals which cannot be dealt with in this paper, a good bibliography can be found in (6) and (11).

Keuchenius (6) points out that the "burred" stems characteristic of a long standing Brown Bast attack have been known since the earliest plantings in the Middle East and were known in the Amazon region in 1887. The earlier stages of Brown Bast, i.e. water-logged bark and stoppage of latex flow, were observed many times in Malaya during 1914, but at this time, following on Rutgers observations and statements (12) respecting the action of *Phytophthora Faberi* (*Maubl*) on the stems of rubber trees, the symptoms were regarded as a possible reaction against this organism, despite the fact that this fungus was never isolated from the diseased tissues by any of the investigators in Malaya.

Pratt (8) in 1917, who had had considerable experience in Malaya before going to Sumatra, was the first observer to record and class the symptoms now described for Brown Bast, as distinct from the symptoms described by Rutgers (12) for the action of *Phytophthora Faberi*. He clearly stated the differences and as a result, concentrated work on Brown Bast became possible.

The senior author took up this work in 1920. The position at that time has been reviewed (11) but a short re-statement may be of interest. The recognition of Brown Bast as distinct from other bark affections and its apparent wide spread distribution, led to the formation of a Brown Bast Investigation Committee (B.B.I.C.) in Malaya.

In Java and Sumatra, various investigators were at work, notably Rands, Keuchenius and Harmsen. The investigations of the B.B.I.C. practically parellelled the work of Rands in Java and the results obtained were almost identical. These results were entirely in favour of the view that Brown Bast must be regarded as a "physiological disease" the cause being non-organic. Keuchenius has steadily supported the "bacterial" origin of Brown Bast and in his latest published work (6) still maintains this view.

Symptoms.

The symptoms have been described repeatedly. The only certain macroscopic symtoms are the cessation or falling-off in latex yield, with the cortical tissues becoming somewhat succulent, i.e., water-logged, and taking on a definite discoloration, ranging from blackish-grey or greyish-brown to a sepia colour. Our own experience shows that the earliest and most usual Brown Bast indication is a slight discoloration of the bark in the tapping cut which appears in small brownish patches or spots. In a number of cases there is a preliminary substantial increase in latex flow, but in an equal number the cut commences to dry and the latex coagulates on the cut. If a tree has been a normal yielder in full foliage and not otherwise diseased, either of these signs is a practically sure indication that a Brown Bast attack is imminent. During the wintering months in Malaya, the drying of the cut alone cannot be accepted as an indication of Brown Bast, as during this period a number of trees become partly or altogether dry.

Keuchenius (6) extends this description as follows :—"und besitz das vermogen zur Metastase." He also points out that various authors, Harmsen (5), Rands (10) and Bobillioff (1) believe that the earliest macroscopic symtoms are antedated by microscopic changes in the affected tissues, and that trees liable to an early Brown Bast attack can be detected by a microscopic examination. He rightly remarks that Brown Bast cannot be diagnosed with certainty unless the macroscopic symtoms are well-marked.

Scope of Present Work.

An overwhelming mass of evidence (11) has accumulated from various sources to show that Brown Bast is nontransmissible. All inoculations have proved unsuccessful up-to-date. Accepting the position as shown by the unsuccessful inoculations, the only line of investigation left open was to try to test the various factors which might influence the incidence of the affection.

Tapping experiments, set up by the B.B.I.C. were in hand when the authors took up this work. These early experiments were designed to test the relative effects of estate routine tapping against the effects of heavy tapping, with varying intervals between successive tappings. The method was based on that used by Rands in Java (11) but a less severe system was finally adopted. The results of this initial series of experiments were unexpected and required confirmation.

Rands was the first investigator experimentally to show that excessive tapping effects the percentage development of Brown Bast to a considerable degree. After preliminary trials had been run in Malaya by the B.B.I.C. Belgrave (then Acting Mycologist) suggested that a single cut per day over the whole circumference would be sufficient to obtain comparative data. It was advisable to approximate as closely as possible to routine conditions, so the least severe tapping system possible under the experimental conditions was desirable.

The initial experiments set up by the B.B I C. consisted of nine plots, testing ¼ Spiral cuts, ½ Spiral cuts, against Full Spiral cuts. Each system was triplicated. *i.e* Every Day (E.D.) Alternate Day (A.D.), and Every Third Day (E.T.D.). The experiments were carried out on the Government Plantation, Teluk Anson. The trees were well-grown, 12 years old, and the estate had been run on the best lines since 1912 when the Department of Agriculture took control. The following tables give the results obtained over a period of nine months, from April, 1919 to December, 1919.

TABLE No. 1.

Tapping System.		Month.	No. of trees in plot.	No. of dry trees when experiment started.	No. of trees tapped.	Total Rubber.	Average yield per tree.
¼ Cut	(Daily	April 1919	554	39	515	67.13	.13
	(Alternate Day		554	24	530	21 8	.05
	(Every Third Day		554	52	502	14.32	.03
½ Spiral	(D.	"	391	50	341	91.51	.30
	(A. D.		390	59	331	33.6	.10
	(E. T. D.		390	40	350	17.37	.05
Full Spiral	(D.	"	613	77	536	231.3	.43
	(A. D.		613	96	517	121.65	.23
	(E. T. D.		613	75	538	65.00	.10
¼ Cut	(D.	May	554	39	515	102.6	.21
	(A. D.		554	21	530	54.2	.10
	(E. T. D.		554	52	502	37.11	.07
½ Spiral	(D.	"	391	50	341	126.10	.37
	(A. D.		390	59	331	59.1	.18
	(E. T. D.		390	40	350	36.7	.10
Full Spiral	(D.	"	613	77	586	346.11	.64
	(A. D.		618	96	517	184.95	.35
	(E. T. D.		613	75	538	178.12	.32

TABLE No. 1—(*contd.*)

Tapping System.		Month.	No. of trees in plot.	No. of dry trees when experiment started.	No. of trees tapped.	Total Rubber.	Average yield per tree.
¼ Cut	(Daily	June 1919	554	39	515	117.22	.23
	(Alternate Day		554	24	530	69.60	.13
	(Every Third Day		554	52	502	43.12	.09
½ Spiral	(D.	,,	391	50	341	185.11	.40
	(A. D.		390	59	331	57 5	.17
	(E. T. D.		390	40	350	41.33	.12
Full Spiral	(D.	,,	618	77	536	355.26	.66
	(A. D.		618	96	517	231.24	.45
	(E. T. D.		618	75	538	166.2	.31
¼ Cut	(D.	July	554	39	515	119.25	.23
	(A. D.		554	24	530	68 95	.12
	(E. T. D.		554	52	502	42.1	.08
½ Spiral	(D.	,,	391	50	341	187.54	.40
	(A. D.		390	59	331	56.2	.17
	(E. T. D.		390	40	350	41.7	.12
Full Spiral	(D.	,,	618	77	536	415.11	.77
	(A. D.		613	96	517	240.20	.46
	(E. T. D.		613	75	538	171.8	.32

Tapping System.		Month.	No. of trees in plot.	No. of dry trees when experiment started.	No. of tappable trees.	Total Rubber.	Average yield per tree.	No. of dry trees (Brown Bast).
¼ Cut	(Daily	Aug. 1919	554	39	515	122.7	.24	...
	(Alternate Day		554	24	530	73.65	.14	
	(Every Third Day		554	52	502	54.8	.10	
½ Spiral	(D.	,,	391	50	341	149.1	.44	...
	(A. D.		890	59	331	68.54	.20	
	(E. T. D.		390	40	350	50.9	.14	
Full Spiral	(D.	,,	613	77	536	369.6	.70	...
	(A. D.		613	96	517	317.14	.61	
	(E. T. D.		613	75	538	255.2	.50	

TABLE No. 1—(*contd.*)

Tapping System.		Month.	No. of trees in plot.	No. of dry trees when experiment started.	No. of tappable trees.	Total Rubber.	Average yield per tree.	No. of dry trees (Brown Bast.)
¼ Cut	(Daily -)	Sept 1919	554	39	512	86.9	.17	3
	(Alternate Day -)		554	24	528	50.	.09	2
	(Every Third Day)		554	52	501	41.27	.08	1
½ Spiral	(D. -)	,,	391	50	339	83.28	.25	2
	(A. D. -)		390	59	329	63.	19	2
	(E. T. D. -)		390	40	350	34.	.09	...
Full Spiral	(D. -)	,,	613	77	491	218.27	.45	45
	(A. D. -)		613	96	505	226.60	.45	12
	(E. T. D. -)		613	75	533	154.21	.30	5
¼ Cut	(D. -)	Oct.	554	39	512	89.44	.17	3
	(A. D. -)		554	24	528	56.24	.10	2
	(E. T. D. -)		554	52	501	55.1	.10	1
½ Spiral	(D. -)	,,	391	50	339	84.3	.28	2
	(A. D. -)		390	59	329	51 9	.16	2
	(E. T. D. -)		390	40	350	54.27	.15	...
Full Spiral	(D. -)	,,	613	77	491	289.4	.60	45
	(A. D. -)		613	96	505	283.2	.56	12
	(E. T. D. -)		613	75	533	307.6	.58	5
¼ Cut	(D. -)	Nov.	554	39	512	89.6	.17	3
	(A. D. -)		554	24	528	57.56	.10	2
	(E. T. D. -)		554	52	501	34.33	.07	1
½ Spiral	(D. -)	,,	391	50	339	110.3	.33	2
	(A. D. -)		390	59	329	65.75	.20	2
	(E. T. D. -)		390	40	350	47.27	.13	...
Full Spiral	(D. -)	,,	613	77	491	311.6	.63	45
	(A. D. -)		613	96	505	269.8	.53	12
	(E. T. D. -)		613	75	533	268.5	.50	5
¼ Cut	(D. -)	Dec.	554	39	510	107.95	.21	5
	(A. D. -)		554	24	528	67.44	.14	2
	(E. T. D. -)		554	52	500	43.72	..085	2
½ Spiral	(D. -)	,,	391	50	333	102.7	.30	8
	(A. D. -)		390	59	328	67.55	.20	3
	(E. T. D. -)		390	40	349	60.13	.17	1
Full Spiral	(D. -)	,,	613	77	484	307.6	.70	102
	(A. D. -)		613	96	483	303.	.60	34
	(E. T. D. -)		613	76	513	271.8	.53	24

The following points are noteworthy:—

(1) The blocks heavily tapped on a Full Spiral, show a high percentage development of Brown Bast.

(2) That Alternate Day tapping compares very favourably with Daily tapping as regards percentage Brown Bast development when a heavy tapping system, (or alternatively when a large quantity of latex is being withdrawn from the tree) is in operation. No certain conclusions can be drawn as to the relative merits of Alternate Day and Daily tapping with reference to Brown Bast, using systems common on plantations, i.e. one-half or one-third cuts.

(3) The apparent sudden jump in number of Brown Bast cases during certain months was noted. The Full Spiral Daily tapping plot showed no Brown Bast cases from April to September; in this month 45 trees with Brown Bast were found. No further cases were noted until December when the total was increased to 102.

(4) Further results of interest are disclosed when the monthly yields are totalled :—

Month.		Daily ¼ cut.	Alt. Daily ¼ cut.	E.T. Day ¼ cut.
		lbs.	lbs.	lbs.
April	...	67.13	24.30	14.32
May	...	102.60	54.80	37.11
June	...	117.22	69.60	43.12
July	...	119 25	68.95	42.10
August	...	122.70	73.65	54.8
September	...	86 90	50.00	41.27
October	...	89 14	56 24	55.10
November	...	89 60	57.56	34.33
December	...	107.95	67.44	43.70
Totals	...	902.79	517.54	365.85

Month.		Daily ½ Spiral.	Alt. Daily ½ Spiral.	E.T. Day ½ Spiral.
		lbs.	lbs.	lbs.
April	...	91.51	33.60	17 37
May	...	126.60	59.10	36.70
June	...	135.11	57.50	41.33
July	...	137.54	56.20	41.70
August	...	149.10	68.54	50.90
September	...	83.28	63.00	34.00
October	...	84,30	51.90	54.27
November	...	110.30	65.75	47.27
December	...	102.70	67.55	60.13
Totals	...	1019.94	523.14	383.67

Month.		Daily F. Spiral. lbs.	Alt. Daily F. Spiral. lbs.	E.T. Day F. Spiral. lbs.
April	...	281.80	121.65	65.00
May	...	346.11	184.95	173.12
June	...	355.26	234.24	166.21
July	...	415.11	240.20	171.28
August	...	369.60	317.14	255.20
September	...	218.27	226.60	154.21
October	...	289.24	383.20	307,60
November	...	311.60	269.80	268.50
December	...	265.60	245.00	271.80
Totals	...	2802.25	2122.78	1832.91

If the total yield on the daily cut is taken as standard and the Alternate Daily and every Third Day totals are multiplied by two and three respectively, the latter totals should fall somewhere near the total for the daily tapping if equal quantities of latex are extracted when equal quantities of bark are removed during tapping systems. The expected results are obtained under the light tapping systems:—

	Daily	¼	cut	Total	...	902.79
Alternate	,,	,,	,,	,, × 2	...	1035.08
E.T. Day	,,	,,	,,	,, × 3	...	1097.55

	Daily	½	Spiral	Total	..	1019.94
Alternate	,,	,,	,,	,, × 2	...	1046.28
E.T. Day	,,	,,	,,	,, × 3	...	1151.01

The blocks tapped on the ½ Spiral system contained 350 trees as against 500 in the remaining blocks.

The Full Spiral blocks compared in the above manner give:—

	Daily	Full	Spiral	Total	...	2802.25
Alternate	,,	,,	,,	,, × 2	...	4245.56
E.T. Day	,,	,,	,,	,, × 3	...	5498.76

The results from the Full Spiral blocks are very much out of line compared with those obtained under lighter or routine tapping. Such results give colour to the view that information obtained under present day conditions may not prove of much value when trees of higher yielding capacities have to be considered. It is practically certain that if such trees are established by vegetative propagation there will be a whole series of new phenomena to be investigated, and from the disease aspect, much danger may be apprehended. From the data obtained in these experiments it seems possible that above a certain yield figure the percentage amount of Brown Bast will be a factor to be considered in the estimation of yields from a particular area, more especially if the land is widely planted with a few high yielding trees per acre. Accepting Brown Bast as a possible limiting factor in the

question of yields, and evidence can be advanced in support of this view, the figures obtained indicate the possibility of restricted yields, according to the type of soil and general growth conditions prevailing, in short, that environmental factors are of primary importance in rubber cultivation. This view is strongly supported by the extremely local chracter of good yielding patches in the great majority of present day stands.

This aspect of the Brown Bast problem is of some practical importance at the present juncture in view of the interest shown in the question of increasing yields per acre by seed selection and vegetative propagation.

PART II.

Tapping Experiments.

The previous experiments showed that the Full Spiral cut, once daily, gave a sufficient number of cases of Brown Bast in a short period, so enabling comparative experiments to be set up. Rands system of tapping, i.e. two superimposed cuts on 1/3 of the circumference, tapped six times per day, was much too drastic to gain a line approximating to routine field operations, for when tapping six times per day in Malaya, no latex is obtained from the last two or three tappings. Under such conditions, the influence of wounding owing to repeated tappings would be of too large significance to enable just conclusions to be arrival at. Many authors have pointed out that typical Brown Bast often originates at badly wounded places, far from the tapping cut. Keuchenius (6) draws special attention to the places where large branches have been broken by the wind and where the tree has been injured about the base as a result of wild pigs eating the bark. This author attaches some importance to these observations in his final conclusions and emphasises them in his consideration of what he terms the "Metastase" of the disease. He states that the features included under the term "Metastase" cannot well be accounted for by a "physiological theory." Therefore it is necessary to attempt to assign to the influence of wounding its own relative importance. Heavy yielding, i.e. too rapid withdrawal of latex, goes hand-in-hand with increased wounding in the tapping operation and in practice, it is difficult to separate these two important factors with regard to the initiation of Brown Bast.

Keuchenius (6) stresses the importance of taking care in the diagnosis of Brown Bast and the writers are in entire agreement. Various authors have held that the early stages of the affection can be spotted by submitting microscopic sections to the "Phloroglucin" test. Keuchenius states that this test is most unsatisfactory, a view supported by our own experience. The only reliable test is the well-marked appearance of the macroscopic symptoms in the field. In order to check our Brown Bast determinations as judged from the mecroscopic symptoms, a series of control trees was set up, and are shown in the tables following. These control trees were healthy trees put out of tapping at the same time that a neighbouring tree was suspected of Brown Bast; the suspected trees were

then tapped until a large area of bark was affected. The final test was the development of "Burrs" on the suspected trees. In all cases, "Burrs" developed on the trees marked for Brown Bast while the controls remained normal.

Previous experiments had indicated that three months preliminary heavy tapping was necessary before valid comparisons could be made as to the behaviour of any plot with regard to the incidence of Brown Bast. The experiments following, may be considered as approximating as closely as possible to routine field operations, but it must be borne in mind that generalisations based on routine tapping systems do not necessarily hold good for a more drastic system, so care is necessary in the final deductions.

The experiments were commenced on 1st August 1920, and 410 trees, were selected and divided into two plots with 207 and 203 trees respectively. The trees in Plot 3 were selected from the trees that had been tapped in the previous experiment on the Full Spiral system once every three days, those in Plot 4 from those tapped on a ½ Spiral once every day. These trees had been rested from Dec. 1919 to Aug. 1920 so had had a good opportunity for recovery from previous tapping operations. The tapping was started in virgin bark above the 36" mark and all the trees were put under a Full Spiral cut, once daily, for three months. This preliminary tapping showed a high number of Brown Bast trees in a portion of Plot 3, eight being counted in a confined area. The total number of Brown Bast trees after three months was 18 in Plot 3 and 7 in Plot 4. This difference might be considered as due to the heavier tapping to which Field 3 had been subjected in the previous experiment, but if the final results are taken into account, as below, it will be obvious that this suggestion is unsatisfactory. The two Full Spiral plots which were formed when Plot 3 was subdivided, gave final totals of 15 and 30 Brown Bast trees respectively and a subdivided plot in Plot 4 under Full Spiral tapping gave 21 Brown Bast trees. A ¾ Spiral plot from Plot 3 gave a final total of 14 and a similar plot from Plot 4 gave the same total of affected trees. A ⅞ Spiral Plot from Plot 4 gave 8 as a final total, but the previous month, eleven months after the starting of experimental tapping, only one Brown Bast tree had been found in this plot It appears obvious that no simple explanation will suffice for the large variations that are met with.

Plots 3 and 4, after the three months preliminary tapping, were subdivided into eight plots of approximately 50 trees each. The presence of boundary drains made it difficult to obtain exact numbers, but as subdivided the plots fell within the limits of the boundary drains and supervision was thus rendered more easy. The position at this stage was :—

Plot	3	A.	55	Full Spiral
„	„	B.	51	„ „
„	„	C.	49	¾ Spiral
„	„	D.	48	½ Spiral

Total=3¼ times the circumference.

Plot	4	A.	45	Full Spiral
"	"	B.	57	¾ Spiral
"	"	C.	44	⅞ Spiral
"	"	D.	55	½ Spiral

Total=3 ⅛ times the circumference.

The number of Brown Bast trees on the change over after subdivision was .—

Plot	3	A.	2	Brown	Bast	Trees.
"	"	B.	6	"	"	"
"	"	C.	3	"	"	"
"	"	D.	7	"	"	"
Plot	4	A.	4	"	"	"
"	"	B.	1	"	"	"
"	"	C.	1	"	"	"
"	"	D.	1	"	"	"

These experiments were concluded in Sept./1921 and the tables are appended. The final figures are given immediately below for comparison to show that no simple explanation can account for the differences observed.

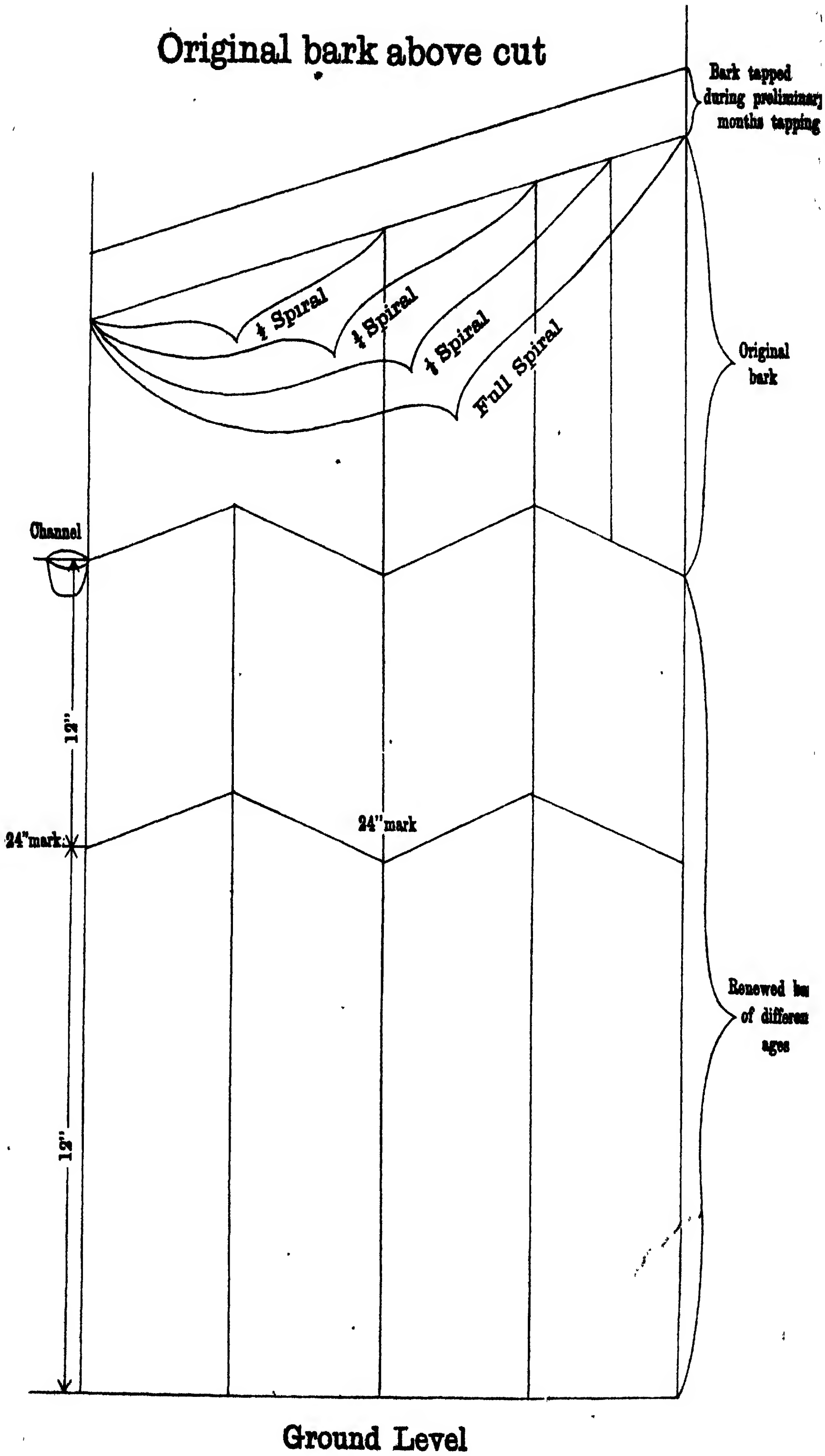
Plot	3	A.	15	Brown Bast	Trees in	Sept./21.
"	"	B.	30	"	"	"
"	"	C.	14	"	"	"
"	"	D.	21	"	"	"
Plot	4	A.	21	"	"	"
"	"	B.	14	"	"	"
"	"	C.	8	"	"	"
"	"	D.	9	"	"	"

Many interesting features were observed during the course of these experiments and can be mentioned in order.

Brown Bast extension on Individual trees.

During the experiment 133 trees out of 410 developed Brown Bast. Of these, seven were not typical although they stopped yielding latex, and in the following analysis are left out of account. The spread of the affection in each individual tree was carefully noted. The extension in area on indidual trees is rapid up to a point, then stops suddenly in the great majority of cases, if tapping is not too long continued. The nature of the retardation or stoppage is illustrated in the diagram.*

*Note;—In the diagram an obvious error has been made in marking the vertical height of the first basal panel. Instead of 12" this figure should be 24".



Original bark above cut
Bark tapped during preliminary months tapping
¼ Spiral
½ Spiral
¾ Spiral
Full Spiral
Original bark
Channel
12"
24"mark
24"mark
Renewed bark of different ages
12"
Ground Level

In only 19 of the affected trees did the disease spread to the ground level. All the other cases, apart from those in which no extension took place after tapping was stopped, showed the disease spreading to a clearly defined position, marked by an apparent difference in age of the previously tapped bark. These positions are the old opening-up marks made when a new panel of bark is about to be tapped. Thus the trees in question initially were opened, when four to five years old, at 24", from the ground level, on a single V. The trees were tapped to the base on this panel, then a similar V was started at the same height on the opposite side. When this panel was finished and the whole circumference of the tree had been tapped down from the 24", a new V was started at the height of 36" and tapping continued down to the 24" mark, and so on. The vertical sequence, from above downwards, is virgin bark passing into young renewed bark, then into older renewed bark. The lines of demarcation between the different types of bark are usually well marked on the tree. The table below summarises the results : —

TABLE No 2.

Total number of Brown Bast trees ...	133= 33% of whole.		
Number of trees on which no extension took place after tapping was stopped ...	40= 30% of attacked trees		
Number of trees on which Brown Bast was confined to the virgin bark, i.e., did not spread through any renewed bark	20= 15%	,,	,,
Number of trees in which Brown Bast spread through the top 12" panel of renewed bark but stopped at 24" Mark ...	17= 35%	,,	,,
Number of trees in which Brown Bast spread to the base of the tree ...	19= 14%	,,	,,

In connection with these figure it may be stated that in the case of trees developing Brown Bast and the extension being stopped on cessation of tapping, the figure 40 represents trees on which absolutely no extension took place. These records are bulky and cannot be given in detail but the records of a typical plot are included to indicate the careful supervision necessary, and the nature of the work. (Page 303.)

When the affection spreads to the base of tree, the downward course varies considerably. In some cases, the affection appeared first in the area below the tapping cut then later in the renewed bark below the virgin bark at the top of the cut, eventually spreading to include all the virgin bark. In other cases the virgin bark was first attacked and extension took place from this point to the base of the tree. In one or two cases, the renewed bark well below the tapping cut became affected with Brown Bast the virgin barked being tapped above remaining healthy. The cases examined show that Brown Bast can extend both laterally and upwards, but was never seen passing from the tapping

cut upwards through recently tapped bark into untapped bark above. Lateral and upward extension is not common ; downward extension commonly takes place in narrow or broad strips which may run to the base without increase in breath.

The important features are the non-extension of Brown Bast in a high percentage of cases when tapping is stopped, and the holding up of Brown Bast extension at the places demarcated by the old opening up cuts. On two occasions, the latter feature has been reported from estates where it had drawn the Managers' attention. It would appear that some physical barrier is imposed owing to the different ages of the tissues at the line of junction or that the physiological differences between different ages of renewed bark are of such account as to almost prevent the extension of the affection from one sector to another. The suggested differences in age are more apparent than real for the cortical tissues are all formed from the same cambium and according to the rapidity of the scaling brought about by the activities of the cork-forming cambium or "phellogen", given sufficient time for renewal, the whole of the cortical tissues will be of the same age.

Examination of the cortical tissues at the junction did not afford any clue as to the probable explanation, for no significant morphological differences were observed.

Comparison of Composite Plots 3 and 4.

A general comparison between the composite plots was attempted, in order to see if any big differences could be detected when yields were calculated in units of bark removed. Plot 3 included 3-A, 3-B, 3-C, 3-D, and Plot 4 the remainder. Lengths of tapping cuts, thickness of bark and vertical height of bark removed during the experimental period, were measured. Though the results obtained can be considered as very approximate only, they provide a check to show that the two big plots could be taken as equivalent and not likely to show any differences which would interfere with the final deductions. The yield per unit inch in length worked out at .2325 for Plot 3 as against .2375 for Plot 4 ; yield per unit m/m in depth gave .80 per Plot 3 as against .825 for Plot 4. Big differences showed in the Brown Bast totals and these must be due to the treatment undergone by each particular plot.

The general position of yields in relation to incidence of Brown Bast is not well defined as a result of the analysis of the figures obtained from the sub-divided plots. From Nov. 1920 to Sept. 1921

the yield and Brown Bast figures are summarised in the table below:—

	Tapping System.	No. of trees Yielding, Nov. 1920.	No. of B.B.trees, Sept. 1921.	Av. tree Yield per. mem.	Per cent. Brown Bast.
Plot 3 A ...	F. Spiral	53	13	1.13	25
„ „ B ...	„ „	43	24	1.19	50
„ „ C ...	¾ „	42	11	0.88	25
„ „ D ...	½ „	36	14	0.98	30
Plot 4 A ...	F. „	36	17	1.80	50
„ „ B ...	¾ „	52	13	1.05	25
„ „ C ...	⅞ „	43	7	0.75	16
„ „ D ...	½ „	48	8	0.61	16

There are no significant relationships shown by the above figures. The figure of quiescent Brown Bast periods following on short periods of intense activity noted in the Part I. experiments, was well marked in most of the sub-divided plots and is indicated in the table below together with the months when the yield was well below the monthly average. The number of the months is used for convenience:—

TABLE No. 8.

——	3.A.	3.B.	3.C.	3.D.	4.A.	4.B.	4.C.	4.D.
Av. Tree yield -	1.13	1.19	0.88	0.98	1.80	1.05	0.61	0,61
Months of Low Av. Tree yield	3.4 5.	3.4 5.	1.2 3.4	11.12 1.2 3.4	1.2 3.	11.12 1.2 3.4	11.12 1.2 3.4	11.12 1.2 3.4
Quiescent B. Bast periods	4.5 6.7	3.4 5.	5.6 7.	12.1 2.5. 6.7	3.4 5.6	3.4 5.6 7.	12.12 1.2.3 4.5.6 7	11.12 3.4.5 6.7

Months of Low Rainfall 12. 4. 5. 6.

Though yield and Brown Bast figures show little apparent relationship, the above summary would appear to indicate that the low rainfall months are, in general, the months during which there is little Brown Bast development. It is accepted that periods of low rainfall result in decreased yields. In this particular instance the influence of the wintering period has to be considered for later work showed a substantial rise in yield during a portion of the dry weather period, following the recovery after wintering. A definite Brown Bast rise was connected with this increased yield during a period of low rainfall.

There is substantial indirect evidence to support the connection between yields and incidence of Brown Bast in the above experiments but few definite conclusions can be arrived at. However, significant observations were made which showed the necessity for prolonged observations. The records collected over a period of three years, show that in our experiments the appearance of Brown Bast in the field was extraordinarily sudden and might be placed in the series of phenomena associated with "trigger action". Daily visits to the plots were made and in the space of 24 hours there would be a sudden increase in the number of Brown Bast cases. Plot 4C which had an abnormally long quiescent period from Aug. 1920 to Sept. 1921 had only one new tree affected up to the beginning of September. On Sept. 6th seven new cases were found in this plot. This feature will be given more prominence when dealing with Plots 4B and 4C. The tapping experiments were continued in these two plots so as to cover a longer period and the results will be considered in detail in the next part.

Immediately following, a typical record from Plot 3A is given. This illustrates the system of recording for all plots and the significant Brown Bast dates are noticeable. The tables of yield figures for all plots are also included.

RECORDS FROM PLOT 3 A. FULL SPIRAL SYSTEM DAILY.

Tree No. 1.— Brown Bast was noticed on this tree before the end of the first three months tapping. Observations on the development of Brown Bast were recorded from 4.11.20.

Brown Bast in this tree extended only down to the edge of the original bark and was limited by it; it extended throughout this area of bark but did not enter the renewed bark below. There was no extension of area from 4.11.20 to 8.9.21 when the last observations were taken.

Tree No. 2.—Brown Bast noticed in this tree before the end of the three months preliminary tapping. Disease first noted on 4.11.20 when the affection was confined to the original bark only on one side of the tree, but on the other side the disease spread through the renewed bark to within one foot of the ground.

On the 6.11.20 the Brown Bast had extended six to nine inches on three-quarters of the tree while in the quarter at the upper end of the cut it was still confined to the original bark. The renewed bark below this portion was very thin and this may have checked the extension in this area.

On the 8.11.20 there was an extension of two to eight inches and on the 10.11.20 the disease had extendad to the base of the tree on one quarter and there was an extension of four to six inches on another quarter. On the upper quarter there was no extension. On the 12.11.20 there was an extension of a few inches and on the 15.11.20 Brown Bast had extended to the base on three-quarters of the circumference. The disease was still confined in the original bark on the upper quarter of the cut. From the 17.11.20 to the 24.11.20 there appeared to be no extension but examination on the 27.11.20 showed that Brown Bast had extended through the thin renewed bark on the upper quarter. On the 8.12.20 the disease had spread to the base of the tree on this quarter. The whole of the tappable portion of the tree had Brown Bast but the bark above the cut was still good. On the 20.7.21 the diseased bark was breaking away and on the 8.9.21 the tree was developing burrs

Tree No. 3.—Brown Bast was first noticed in this tree on the 30.12.20 when it extended down to the 24 inch mark, on three-quarters of the tree; the remaining quarter of the tree was free. There was no further extension until the 10.1.21 when the free quarter showed a downward extension of some five inches. On the 18.5.21 there was a slight extension below the 24 inch mark of some three to four inches but since this date there has been no further extension.

Tree No. 4.—Brown Bast was first noticed on the 30.12.20 when it had extended down to the 24 inch mark on three-quarters of the tree and from two to eight inches into renewed bark on the other quarter. No extension took place until the 19.4.21 when a small patch was found affected beneath the upper end of the cut. No extension up to 8.9.21 when the tree was forming burrs above the 24 inch mark.

Tree No. 5.—Brown bast first noticed on the 30.12.21 when it extended through the original bark and one to two inches into the renewed bark. On the 25.2.21 there was an extension downwards of eight inches on a strip three inches wide and on the 2.5.21 there was a further extension on a patch of four inches square at the side of the previous extension. Up to 8.9.21 no further extension.

Tree No. 6.—Brown bast first noticed on 30.12.20 when it had extended to the base of the tree on one quarter and in strips of from two to fifteen inches into the renewed bark on the other three quarters.

No extension until 31.1.21 when patches of a few inches extension were recorded. On the 2.5.21 the base of the tree was affected over three quarters of the circumference, while the other quarter was affected to the 24 inch mark. No extension to be reported on the 8.9.21.

Tree No. 7.—Brown bast first noticed on the 20.2.21, when it extended through the original bark and from two inches to two feet into renewed bark in a wedge shaped patch. On the 19.4.21 the disease had extended one and a half feet down the tree on a strip eight inches wide beneath the upper end of the cut. On the 2.5.21 there was extension to the base of the tree on a strip fourteen inches by two inches and on the other side of tree a small patch about three inches square was found. On the 18.5.21 there was extension on a strip ten inches long by two leaving a strip of one and a half to two inches of healthy bark between. On the 6.8.21 there was an exten sion on a strip twelve inches long by two inches wide. Up to the 8.9.21 there was no further extension ; on this date the Brown Bast was confined to bark above the 24 inches mark over half the tree and on the other half it had extended to within a few inches of the base of the tree.

Tree No. 8.—Brown Bast first noticed on the 1.4.21 when it extended through the original bark only at the lower end of the cut, and from one to four inches into renewed bark on the other parts of the tree. On the 20.4.21 there was an extension on a patch one and a half to four inches wide. Since there has been no development.

Tree No. 9.—Brown Bast first noticed on the 1.4.21 when it had extended eighteen inches into the renewed bark at the lower end of the cut, and on half of the tree the extension varied from just below the original bark to eighteen inches below this mark. The upper half of the cut remained healthy On the 6 6.21 there was a further small extension but no further development since.

Tree No. 10.—Brown Bast first noticed on the 1 4.21 when it had extended one to four inches into renewed bark on half the tree. On the other half of the tree Brown Bast was limited to the original bark. On the 19.4 21 there was a small extension in the original bark but since no further development. The Brown Bast bark was splitting off on the 8.9.21.

Tree No. 11.—Brown Bast first noticed on the 1.4.21 when it had not extended beyond the original bark. A small strip of bark in the centre of the cut remained healthy. On the 8.9.21 the disease had extended throughout the original bark and about three inches into the renewed bark.

Tree No. 12.—Brown Bast first noticed on the 1.4.21 when it was limited to the original bark. On the 19.4.21 there was an

extension on a small patch three inches long. On the 8.9.21 Brown Bast was confined to the original bark on three-quarters of the tree and was half-an-inch down from the cut in the other quarter where there was no original bark. On this latter date the affected bark was splitting and breaking off.

Tree No. 13.—Brown Bast first noticed on the 1.4.21 when it had developed in a strip eight inches wide and eighteen inches down the tree in the centre of the cut. There appears to have been no extension since.

Tree No. 14.—Brown Bast first noticed on the 1.4.21 when it appeared five inches below the cut, (there was no sign of the affection on the cut) and extended to the base of the tree on a single strip. Extension has since taken place in narrow strips.

TABLE No. 4.

CASTLETON ESTATE.

BROWN BAST EXPERIMENTS.

Yields for August 1920.

--	Plot	No. of trees	Volume of latex		Latex Rubber	Lump Rubber	Scrap Rubber	Total Yields	Yield per tree per month
			gls.	pts.	lbs.	lbs.	lbs.	lbs.	
Full Spiral	3A	207	39	1	169.75	..	36	1[illegible]5.75	.70
,,	4B	203	41	1	106.5	...	32.6	139 125	.70

Yields for September 1920.

Full Spiral	3A	207	99	7¼	226.6	9.00	50.7	286.3	1.4
,,	4B	203	82	3¾	168	8.3	51.8	227.37	1.1

Yields for October 1920.

Full Spiral	3A	207	82	5½	174.3	11.00	33.2	218.56	1.1
,,	1B	203	66	3¼	132.9	5.56	25.2	163.7	.80

TABLE NO. 4—(*contd.*)

CASTLETON ESTATE.

Yields from Brown Bast Experiments August to October, 1920.

Plot No.	System of tapping.	Month.	No. of trees.	No. of Brown Bast trees.	No. of control trees.	Total No. of trees tapped.	Total Rubber. lbs.	Average Yield per tree.
3A	Full Spiral	Nov. 1920	55	2	...	53	39.25	.75
B	„ „		51	7	1	43	33.56	.77
C	¾ „		49	5	2	42	25.80	.60
D	½ „		48	10	2	36	22.30	.61
4A	Full „		45	7	2	36	36.00	1.00
B	¾ „		57	3	2	52	31.9	.61
C	⅞ „		44	1	0	43	21.06	.49
D	½ „		55	4	3	48	19.25	.40
3A	Full Spiral	Dec.	55	6	4	45	44.6	.90
B	„ „		51	11	2	38	36.25	.90
C	¾ „		49	7	2	40	28.00	.70
D	½ „		48	13	4	31	24.5	.79
4A	Full „		45	8	5	34	53.75	1.59
B	¾ „		57	5	1	48	40.30	.86
C	⅞ „		44	1	0	43	27.30	.63
D	½ „		55	1	3	48	26.9	.56
3A	Full Spiral	Jan. 1921	55	6	4	45	54.9	1.22
B	„ „		51	11	2	38	42.125	1.11
C	¾ „		49	8	2	39	26.25	.67
D	½ „		48	13	4	31	23.60	.76
4A	Full „		45	10	5	30	42.90	1.43
B	¾ „		57	7	6	44	36.70	.83
C	⅞ „		44	1	0	43	24.50	.56
D	½ „		55	4	3	48	22.90	.48
3A	Full Spiral	Feb.	55	7	4	44	42.75	.97
B	„ „		51	12	2	37	34.70	.92
C	¾ „		49	8	2	39	23.30	.59
D	½ „		48	13	4	31	20.25	.65
4A	Full „		45	11	5	29	39.125	1.35
B	¾ „		57	10	9	38	34.125	.82
C	⅞ „		44	1	0	43	23.8	.55
D	½ „		55	5	4	46	20.00	.31
3A	Full Spiral	March	55	7	4	44	38.125	.86
B	„ „		51	15	2	34	29.125	.80
C	¾ „		49	9	2	38	20.50	.54
D	½ „		48	15	4	29	16.60	.51
4A	Full „		45	15	5	25	35.00	1.40
B	¾ „		57	13	9	35	27.85	.74
C	⅞ „		44	2	0	42	20.8	.48
D	½ „		55	6	4	45	17.8	.39

TABLE No. 4—(*contd.*)

CASTLETON ESTATE.

Yields from Brown Bast Experiments August to October, 1920.

Plot No.	System of tapping.	Month.	No. of trees.	No. of Brown Bast trees.	No. of control trees.	Total No. of trees tapped.	Total Rubber. lbs.	Average Yield per trees.
3A	Full Spiral		55	14	4	37	36 75	.99
B	,, ,,		51	16	2	33	30 30	.92
C	¾ ,,		49	9	2	38	20.50	.54
D	½ ,,	April	48	15	4	29	18.37	.63
4A	Full ,,	1921	45	16	5	24	41.50	1.70
B	¾ ,,		57	13	9	35	32.7	.94
C	⅞ ,,		44	2	0	42	26.44	.63
D	½ ,,		55	6	4	45	21.25	.47
3A	Full Spiral		55	14	4	37	50.60	1.36
B	,, ,,		51	16	2	33	39.00	1.18
C	¾ ,,		49	12	2	35	31.75	.90
D	½ ,,	May	48	18	4	26	29 00	1.11
4A	Full ,,		45	16	5	24	58.30	2.41
B	¾ ,,		57	13	9	35	43.125	1.23
C	⅞ ,,		44	2	0	42	40.06	.95
D	½ ,,		55	6	4	45	37.44	.83
3A	Full Spiral		55	14	4	37	44.75	1.20
B	,, ,,		51	20	2	29	38.41	1.23
C	¾ ,,		49	12	2	35	32.44	.92
D	½ ,,		48	18	4	26	30.25	1.16
4A	Full ,,	June	45	16	5	24	33.50	1.39
B	¾ ,,		57	13	9	35	30.7	.87
C	⅞ ,,		44	2	0	42	29.9	.71
D	½ ,,		55	6	4	45	25.9	.57
3A	Full Spiral		55	14	4	37	41.37	1.11
B	,, ,,		51	21	2	28	39.00	1.39
C	¾ ,,		49	12	2	35	36.37	1.04
D	½ ,,		48	18	4	26	33.00	1.26
4A	Full ,,	July	45	18	5	22	46.37	2.11
B	¾ ,,		57	13	9	35	47.37	1.71
C	⅞ ,,		44	2	0	42	41.6	.99
D	½ ,,		55	6	4	45	33.85	.75
3A	Full Spiral		55	14	4	37	61.7	1.66
B	,, ,,		51	21	2	28	53.44	1.89
C	¾ ,,		49	12	2	35	59.00	1.68
D	½ ,,		48	18	4	26	41.9	1.74
4A	Full ,,	August	45	18	5	22	62.125	2.83
B	¾ ,,		57	13	9	35	57.125	1.63
C	⅞ ,,		44	2	0	42	52.56	1.25
D	½ ,,		55	6	4	45	47.06	1.04

TABLE No. 4—(*contd.*)

CASTLETON ESTATE.

Yields from Brown Bast Experiments August to October, 1920.

Plot No.	System of tapping.	Month.	No. of trees.	No. of Brown Bast trees.	No. of con-trol trees.	Total No. of trees tapped.	Total Rubber. lbs.	Average Yield per trees.
3A	Full Spiral	Sept. 1921	55	15	4	36	48.125	1.33
B	„ „		51	30	2	19	35.56	1.67
C	¾ „		19	14	2	33	48 125	1.45
D	½ „		48	21	4	23	33.50	1.45
4A	Full „		45	21	5	19	47.50	2.50
B	¾ „		57	14	9	34	44.37	1.30
C	⅞ „		44	8	0	36	40.60	1.12
D	½ „		55	9	4	12	10.20	.95

CONTINUED TAPPING EXPERIMENTS ON PLOTS 4 B. AND 4 C.

In view of the endeavours of Rands (11) to obtain trees of *Hevea brasiliensis* immune to Brown Bast, the records of Plot 4 C. over the tapping period from August 1920 to September 1921, were of some significance. It was decided to continue the experiments to see if the sudden rise in number of Brown Bast cases on September 6th in this plot indicated a definite change in Brown Bast behaviour. Plot 4 B. had functioned normally in this connection and tapping was continued in this plot to control the further observations to be made on Plot 4 C. The table below gives the essential details.

TABLE No. 5.

FOR LONG-TAPPING PERIOD FOR PLOTS 4B AND 4C.

From November, 1920 *to December*, 1922. *Duration* 26 *months*.

Plot and tapping system.	Date.	No. of trees.	No. of Yield-ing trees.	No. of B. Bast trees.	No. of Con-trol trees.	Total Yield.	Aver-age Mon-thly Yield.	Total Rise in B. Bast trees.	Special B. Bast Date.
4B ¾ Spiral	Nov.	57	52	3	2	31.90	.61		
4C ⅞ „	1920	44	43	1	0	21.06	.49	2	
4B ¾ „	Dec.	57	48	5	4	40.30	.86		
4C ⅞ „		44	43	1	0	27.30	.63	2	17.12.20
4B ¾ „	Jan,	57	44	7	6	36.70	.83		
4C ⅞ „	1921	44	43	1	0	24.50	.56	2	5.1.22

TABLE No. 5—(*contd.*)

FOR LONG-TAPPING PERIOD FOR PLOTS 4B AND 4C.

From November, 1920 *to December*, 1922. *Duration* 26 *months*.

Plot and tapping system.	Date.	No. of trees.	No. of Yielding trees.	No. of B. Bast trees.	No. of Control trees	Total Yield.	Average Monthly Yield.	Total Rise in B. Bast trees.	Special B. Bast Date.
4B $\frac{3}{4}$,,	Feb.	57	38	10	9	31.125	.82		
4C $\frac{7}{8}$,,		44	43	1	0	23.80	.55	3	1.2.21
4B $\frac{3}{4}$,,	March	57	35	18	9	27.85	.74		
4C $\frac{7}{8}$,,		44	42	2	0	20.80	.48	4	31.3.21
4B $\frac{3}{4}$,,	April	57	35	13	9	32.70	.94		
4C $\frac{7}{8}$,,		44	42	2	0	26.44	.63	...	
4B $\frac{3}{4}$,,	May	57	35	13	9	43.125	1.23		
4C $\frac{7}{8}$,,		44	42	2	0	40.06	.95	...	
4B $\frac{3}{4}$,,	June	57	35	13	9	30.70	.87		
4C $\frac{7}{8}$,,		44	42	2	0	29.90	.71	...	
4B $\frac{3}{4}$,,	July	57	35	13	9	47.37	1.71		
4C $\frac{7}{8}$,,		44	42	2	0	41.06	.99	...	
4B $\frac{3}{4}$,,	Aug.	57	35	13	9	57.125	1.63		
4C $\frac{7}{8}$,,		44	42	2	0	52.55	1.25	...	
4B $\frac{3}{4}$,,	Sept.	57	34	14	9	44.37	1.30		
4C $\frac{7}{8}$,,		44	36	8	0	40.60	1.12	7	6.9.21
4B $\frac{3}{4}$,,	Oct.	57	36	14	7*	37.63	1.04		
4C $\frac{7}{8}$,,		44	36	8	0	23.94	.66	..	
4B $\frac{3}{4}$,,	Nov.	57	36	14	7	47.19	1.31		
4C $\frac{7}{8}$,,		44	33	11	0	45.38	1.37	3	9.11.21
4B $\frac{3}{4}$,,	Dec.	57	32	18	7	48.31	1.51		
4C $\frac{7}{8}$,,		44	33	11	0	46.38	1.41	4	17.12.21
4B $\frac{3}{4}$,,	Jan.	57	30	20	7	32.88	1.10		
4C $\frac{7}{8}$,,	1922	44	32	12	0	33.56	1.05	3	
4B $\frac{3}{4}$,,	Feb.	57	30	20	7	30.75	1.02		
4C $\frac{7}{8}$,,		44	30	14	0	30.44	1.01	2	

* Two control trees put into ¾ Spiral Plot to make up equal number of yielding trees at the end of September on continuation of experiment.

TABLE No. 5—(*contd.*)

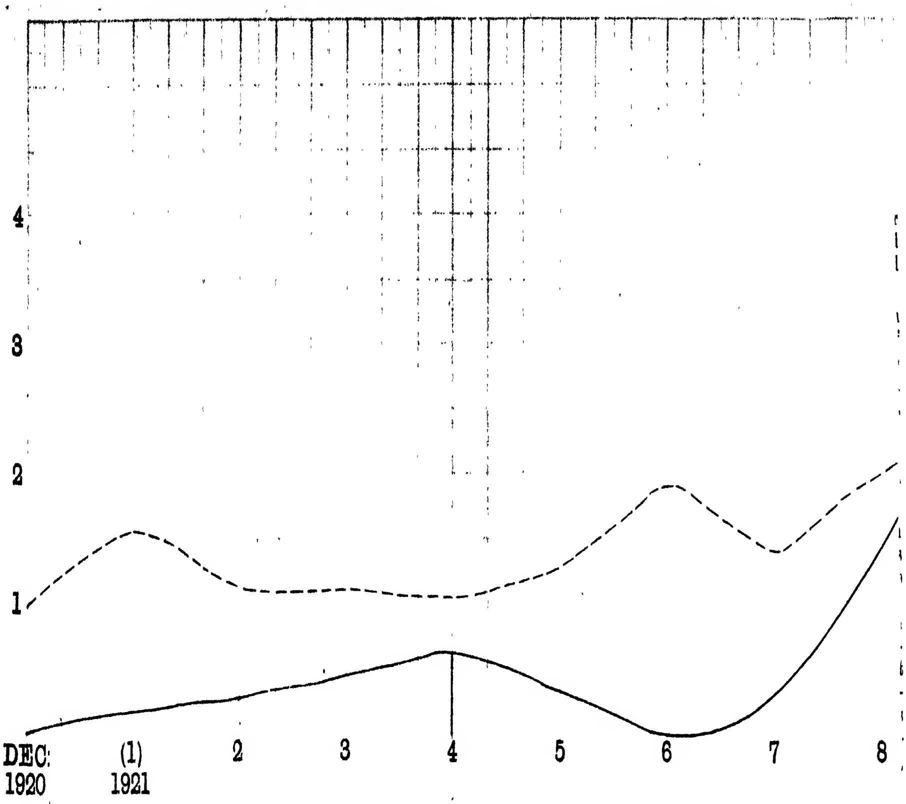
FOR LONG-TAPPING PERIOD FOR PLOTS 4B AND 4C.

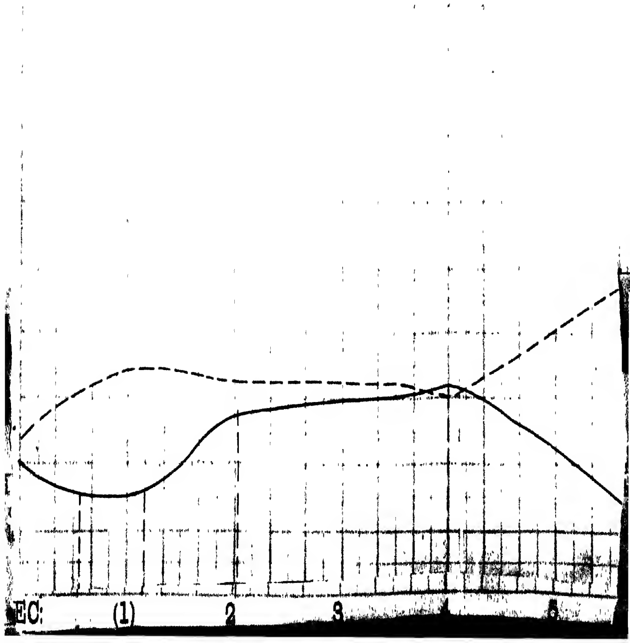
From November, 1920 *to December*, 1922. *Duration* 26 *Months.*

Plot and tapping system.		Date.	No. of trees.	No. of Yielding trees.	No. of B. Bast trees.	No. of Control trees	Total Yield.	Average Monthly Yield.	Total Rise in B. Bast trees.	Special B. Bast Date.
4B $\frac{3}{4}$	,,	March	57	28	22	7	37.88	1.35		
4C $\frac{7}{8}$	,,		44	28	16	0	37.81	1.35	4	18.3.22
4B $\frac{3}{4}$	,,	April	57	27	23	7	37.50	1.39		
4C $\frac{7}{8}$	,,		44	27	17	0	36.88	1.37	2	
4B $\frac{3}{4}$	,,	May	57	22	28	7	41.75	1.90		About
4C $\frac{7}{8}$	,,		44	26	18	0	42.19	1.62	6	7.5.22
4B $\frac{3}{4}$	,,	June	57	18	32	7	39.75	2.21		
4C $\frac{7}{8}$	,,		44	26	18	0	38.00	1.46	4	20.6.22
4B $\frac{3}{4}$	,,	July	57	16	34	7	26.19	1.61		
4C $\frac{7}{8}$	,,		44	21	23	0	28.31	1.35	7	6.7.22
4B $\frac{3}{4}$	,,	Aug.	57	14	36	7	16.63	1.19		
4C $\frac{7}{8}$	,,		44	19	25	0	19.81	1.04	4	
4B $\frac{3}{4}$	,,	Sept.	57	13	37	7	19.94	1.53		
4C $\frac{7}{8}$	,,		44	17	27	0	18.88	1.11	3	
4B $\frac{3}{4}$	,,	Oct.	57	11	39	7	16.00	1.45		
4C $\frac{7}{8}$	,,		44	17	27	0	17.00	1.00	2	
4B $\frac{3}{4}$	,,	Nov.	57	8	42	7	11.88	1.48		
4C $\frac{7}{8}$	,,		44	16	28	0	14.44	.90	4	
4B $\frac{3}{4}$	,,	Dec.	57	2	48	7	6.13	3.06		
4C $\frac{7}{8}$	,,		44	8	36	0	16.00	2.00	14	17.12.22

The "trigger action" nature of the Brown Bast increase is well shown in Table No. 5. Up to the end of 1922 the sharp rise following a quiescent period is in evidence and must have considerable significance. The curves for yield and Brown Bast development are given below.

In considering increases in average yield figures, it should be remembered that as tapping is continued from the 36" mark downwards, the circumference increases appreciably and the tapping cuts increase in length with a presumed corresponding increase in yield.





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Again it may be noted that if the special Brown Bast dates appear towards the middle of the month some correction in average tree yield is necessary. These corrections resulted in a change in the second decimal figure only and so were of little importance.

The dotted curve represents Average Tree Yield per month (A.T.Y.M.) and the line curve Percentage Increase in Number of Brown Bast Trees (P.I.B.B.) in relation to actual number of trees in tapping. The number of trees in tapping decreases month by month as more trees succumb to Brown Bast and are taken out of tapping. The ordinates for the P.I.B.B. are represented as dotted for the Special Brown Bast dates and full lines for ordinary increases which were observed during the month ; these latter are totalled and the vertical column erected for the last day of the month.

Owing to a typewriting error escaping notice whilst dealing with the masses of figures the P.I.B B. curves are not absolutely accurate as from May, 1922 to December, 1922 onwards The actual percentage increases in Brown Bast for the months mentioned are given below. The error makes no difference to the general trend of the curve and does not affect the argument as the tabled figures show. These indicate the large percentage increases in Brown Bast in both plots about May, June and July, which though months of low rainfall showed increased Average Monthly Tree Yields over previous months. This period of intense Brown Bast activity is followed by a period of ordinary increases, with no special Brown Bast dates, up to November, December, 1922, when another burst followed.

		¾ Spiral.	⅞ Spiral.
May	...	5 in 27 = 19%	1 in 27 = 4%
June	...	4 , 22 = 18%	0 ,, 26 = —
July	...	2 ,, 18 = 11%	5 ,, 26 = 20%
Aug.	...	2 ,, 16 = 12½%	2 ,, 21 = 10%
Sept.	...	1 ,, 14 = 7%	2 ,, 19 = 10%
Oct.	..	2 ,, 13 = 15%	0 ,, 11 = —
Nov.	...	3 ,, 11 = 27%	1 ,, 17 = 5%
Dec.	...	6 ,, 8 = 76%	8 ,, 16 = 50%

Accepting the Special Brown Bast dates as of more than ordinary significance it will be seen that the P.I B B. curves follow one another closely as from September 9th, 1921, up to which date the ⅞ Spiral plot had shown marked resistance to the onset of Brown Bast, as from December 1910 to September 1921. In general it would appear that there is a well marked rhythm, corresponding with the poor and good yielding periods of the year ; the poor yielding period includes the approach of the wintering season, the period of wintering and a short period afterwards until the tree recovers its full activities. The good yielding period covers the remainder of the year and is influenced largely by climatic conditions.

In particular, the ⅞ Spiral plot shows a decidedly low Average Tree Yield per Month coupled with strong resistance to the onset of Brown Bast. Comparison of the curves of the two plots has to be made on the reckoning that the ⅞ Spiral plot has 12½ % more bark removed than the ¾ Spiral ; the Average Monthly Tree Yield from the ⅞ Spiral plot is lower, on the whole, from December, 1920 to September, 1921, in spite of the greater amount of bark removed.

The sudden rise in Percentage Number of Brown Bast cases on September 6th, 1920 in Plot 4 C. appears directly correlated with a sudden increase in Average Tree Yield per month. Up to August 1921 this was always below 1.00. This figure increased in August 1921 and September 1921 to 1.25 and 1.21 respectively; after November 1921 the figure remained above 1.00 until November 1922, and during this period the plot developed Brown Bast in a manner similar to other plots. If a comparison between the two curves plotted for yield is made for the period after September, 1921. no big differences can be found excepting when a big increase signifies a big Brown Bast increase as in May, June and July for the ¾ Spiral plot. A close study of these curves both from a a general and particular point of view, indicates some close connection between yields and Brown Bast incidence. For the particular area in question, strong evidence is brought to show that Brown Bast and excessive yielding are directly connected. The macroscopic appearance of Brown Bast is in the nature of a stimulus followed by a sudden release, and during certain periods of the year there is practically no Brown Bast development. In 1919 sudden increases in Brown Bast cases took place in September and December. In 1920 small increases took place in November and December, and in 1921 in January, February and March. The next five months, in general were quiescent, but a sudden rise took place again in September. November and December/1921, January, February, March and April/1922 show average increases but May, June and July, in the previous year quiescent months. were heavy Brown Bast months followed by a quiet period until December; only a small increase was reported in September/22 though the previous two years this month was a notably heavy Brown Bast month. In December/22, when only twenty-four trees were still yielding, the "trigger action" phenomenon was most pronounced, fourteen fresh cases being reported on December 17th.

As far as the records go, the quiescent Brown Bast periods do not fall in any particular months, though had 1922 observations supported those obtained in previous years it would have been possible to state that the months of and immediately following wintering were months of low Brown Bast development. The records indicate that if the yield figures are high in consecutive months there is likely to be a large increase in number of Brown Bast cases, this increase being followed by a comparatively quiet period. Also that high yields may be obtained in months of low rainfall, as in May, 1922 with 5.24 ins., June, 1922 with 3.05 ins. and July, 1922 with 2.84 ins. and as indicated above, these were heavy Brown Bast months.*

More work is required clearly to elucidate the correlations, but there seems little reason to doubt the close connection between Brown Bast development and the amount of latex extracted. It should be clearly understood that the term "excessive yielding" does not imply that the highest yielding plots are less resistant to Brown Bast, but that under the general growth conditions, which may vary considerably even in contiguous plots, a limit is set on the amount of latex which can be extracted without setting up conditions favourable for the

*See Rainfall records at end of article.

development of Brown Bast. This limit will be higher or lower as the conditions are more or less favourable for yielding.

The features to which attention has been specially drawn cannot be lucidly explained without accepting some "physiological theory," and these have appeared so constantly over an extended experimental period that it is probable that further support will be forthcoming when they are repeated on other estates with different soil conditions; in this connection it is advisable to emphasise that our results can be taken to apply only to conditions similar to those on Castleton Estate. We are of the opinion that environment plays a prominent role in questions relating to yield, and small environmental changes, may result in large modifications of experimental results. It will be obvious to other workers in this field that results from a single plot are not likely to prove of much value.

We intend to attempt an explanation on the basis of exhaustion and it might be convenient to make our attitude clear at this point. Many investigators have suggested a similar explanation, but most have inclined to the view that the elaborated food materials lost by the extraction of the latex are of supreme importance. The writers are of the opinion that the water constituent of the latex is of first importance in this problem; that the normal physico-chemico relationships which govern the distribution of water throughout the plant tissues are seriously disturbed when amounts of latex beyond a certain limit, are being extracted. As a result of this disturbance the macroscopic symptoms known as Brown Bast appear in the cortical tissues

The facts obtained contradict Keuchenius's statement (6) that "the theory of high yielding with consequent exhaustion, and "large wounding influence cannot account for the features observed, "as in such cases of heavy tapping experiments *the disease figure* "*would increase largely, which is not the case.*" He states this opinion in a synopsis dealing with the factors which are insufficiently accounted for by a "physiological theory", and the opinion is based on three heavy tapping experiments which were each continued for one month only. A criticism of the results of experiments of such short duration is superfluous in the light of our results, which surely render the position of Keuchenius untenable on this important point.

Many observers have dealt with the Brown Bast problem in a general way and have considered the various factors which might influence the incidence of the disease. These factors, Rainfall, Light and Moisture, Age of the Trees, Height of Tapping Cut etc. are all interconnected with yield, yet in the majority of experiments conducted with a view to elucidating these factors, no yield figures are given. Keuchenius (6) does not give yield figures for any of the following sections (*a*) Rainfall and Frequency of the disease (*b*) Light, Moisture and Frequency of the disease (*c*) Age of the trees and Frequency of the disease (*d*) Height of Tapping Cut and Frequency of the disease (*e*) Connection between Tapping System and Frequency of the disease (*f*) Tilling of the Soil and Frequency of the disease. He considers that some of these factors (presumably apart from question of yield) have considerable influence on the incidence of Brown Bast. We have dealt with Rainfall and shown decisively that heavy Brown

Bast periods may coincide with dry periods, if the yield continues high over the dry period.

Keuchenius says with regard to this question, " The effect of the " rainfall, mentioned above, in my opinion, should be directly con- " nected with increase of moisture (in soil and air) and the decrease " in intensity of the sunshine due to clouding of the sky. The high " disease percentage on innumerable mountain estates in Java, espe- " cially when coffee is interplanted in the shade of the Hevea as a " secondary cultivation, is in agreement herewith. The influence of " light and moisture, both of which factors to a certain extent are " interdependent, meanwhile also makes its presence felt in other ways " than an increase of the disease percentage............A number of " observations have convinced me that with lack of light and with " increase of moisture, Brown Bast occurs in far more serious form " etc."

In Malaya, at least, conditions as depicted in the above quotation would result in definite increases in yield. Planters claim an increased yield of some 20% if tapping can be started an hour earlier in the morning and on misty mornings the trees drip latex for considerably longer periods than on clear days when the full effect of the sun is felt.

PART III.

Further Tapping Experiments.

The previous experiments opened up many questions on which further information was desirable. The following points were considered important.

(1). The stoppage of Brown Bast extension at definite places delimited by an apparent difference in age of renewed bark, i.e. the old opening-up cuts. This feature might be of practical importance in the question of treatment.

Plot A.—This plot was first tapped for two months on a Full Spiral at a height of 27" then a similar cut was started 9" above ; a depression of two inches of recently renewed bark was thus inserted, separating and isolating the bark below from that above, in which Brown Bast would appear as the heavy tapping was carried forward. The previous experiments had suggested that the affected areas might be limited by interposing a recently renewed area ; in this manner the untapped areas below might be protected.

Plot B.—Similar to Plot A, but a narrow depression of half-an-inch only of recently renewed bark interposed between the upper and lower bark areas.

(2). To ascribe the proper significance resulting from the amount of latex extracted as against the wounding influence set up during the tapping operation

Plot C.—An attempt to obtain evidence re (2) was made as follows. It is commonly assumed, and practice supports the assumption, that tapping during the heat of the day results in decreased yields as compared with tapping in the early hours. Plot C was tapped on a Full Spiral, once daily, at mid-day, during the experiment, and accepting the above statement, this plot should have given decreased yields though the wounding influence would be equivalent to that in other plots, tapped early.

Plot D.—This plot was tapped lightly, once daily, on a Full Spiral, as a control for Plots C. and E. Light tapping, involving only the less tender, outer cortical tissues, would result in less irritation and decreased yield.

Plot E.—This plot was set up to endeavour to obtain evidence re (2). Tapped similarly to the above plots and the latex coagulated on the tapping cut with a 2½ % solution of Acetic Acid.

(3). Is any special significance to be attached to the system of tapping in the abnormal plot, i.e. ⅞ Spiral.

Plot F.—Put under a ⅞ Spiral to see if the previous results could be supported.

Plot G—This plot was put in on November, 1st 1921 as a control for Plot B. The trees were tapped on a ½ Spiral. Following the method of treatment developed by Keuchenius (6), a deep depression, cut down to the wood, was interposed to protect the lower bark areas, previous to the experimental tapping. This depression was narrow but deep enough to completely isolate the bark below from that being tapped above.

The plots contained 50 trees each and all were subjected to the three months preliminary heavy tapping to test for abnormalities as regards their behaviour to Brown Bast. Plot G, is not included in these remarks, but the records are given in the final tables at the end of this portion for purposes of comparison if necessary.

SUMMARY OF TOTAL YIELDS AND BROWN BAST TREES.

(1). Three months preliminary heavy tapping September, 1st 1921 to November, 31st 1921.

Plot	Brown Bast Trees.	Total Yields.
A	10	117.45 lbs.
B	9	159.01 ,,
C	9	135 88 ,,
D	12	138.95 ,,
E	10	144.87 ,,
F	13	143.82 ,,

(2). Heavy Tapping from December, 1st 1921 to April, 31st 1922.

Plot.	Brown Bast Trees Apr. 31st.	Brown Bast Trees May 31st.	Total Yields.	Increase in number of B. Bast Trees.
A	29	29	133.26 lbs.	19
B	19	20	179.89 ,,	11
C	18	29	169.63 ,,	20
D	13	16	83.51 ,,	4
E	17	23	125.82 ,,	13
F	16	18	166.89 ,,	5

The taking of records was stopped on May 1st, but tapping was continued through May to see if more trees became affected with Brown Bast. The April and May columns above for Plots C and E show the big differences which may quickly appear in short term experiments and emphasise the necessity for carrying on Brown Bast tapping experiments over a sufficiently long period in order to obtain trustworthy results.

The general results are concordant with the experimental evidence obtained previously. Out of 350 trees, 138 (39%) developed Brown Bast. The affection was confined to the original bark in 122 trees; in only 16 cases did Brown Bast spread to any extent.

The evidence obtained in these experiments showed conclusively that if Br wn Bast is detected sufficiently early and tapping is stopped immediately, there is little extension in the great majority of cases. Many cases were noted with the affection extending half-an-inch to one inch downwards from the cut. Tapping was stopped for a month and on resumption there was usually no signs of Brown Bast, but when tapping was continued, some cases developed the affection more seriously while others remained free. This observation is of importance in connection with the attempts of Rands (11) to establish trees immune to Brown Bast.

Though the above remarks suggests that Brown Bast can be checked by careful supervision, it should be noted that, under plantation conditions, the same careful supervision to each individual tree cou'd not be given, and it is doubtful if we could hope for similar results.

Plots A and B and G gave positive evidence with reference to preventing extension of Brown Bast on individual trees. Plot A, with a wide depression at ordinary tapping depth, only two out of twenty-five showed signs of Brown Bast below the depression. Plot G, with a deep narrow cut down to the wood, showed complete isolation in all cases. Plot B, with a narrow depression at ordinary tapping depth, fourteen out of twenty cases passed across the depression.

These results are interesting. Keuchenius (6), in developing his theory as to the origin of Brown Bast, attaches some importance to the successful isolation of Brown Bast by means of deep cuts to the wood. The above results show that practically the same end is attained without deep cuts but the isolation cuts at ordinary tapping depth must be sufficiently wide to function successfully.

It is worthy of remark that a considerable reduction in amount of total rubber is found when wide or deep depressions are utilised as isolation cuts, as in Plots A and G, for when the cut being tapped comes within two inches of the depressions, the majority of the trees go dry or yield only a small amount, though Brown Bast cannot be detected. Such cases provide instances of large wounding influence with a decrease in yield, but no increase in Brown Bast, indicating that the amount of latex extracted is the factor of greatest importance in the initiation of Brown Bast. The narrew depression in Plot B, did not interfere with the yield in this manner.

Positive evidence was hoped for from Plot C, but only a slight falling off in yield was found as compared with the remaining plots, which were tapped in the early hours of the morning. As pointed out previously, it is evident that estate practice does not prove a reliable guide when heavy tapping with a correspondingly high yield is the order of the day.

The results from Plot D were expected. Light tapping means less wounding and decreased yields because the internal, rich-in-latex layers are not touched by the knife.

Again the 7/8 Spiral plot behaves abnormally when the change-over is made. Tapping was carried on for a short period only in these experiments; the previous records show that little can be gathered unless the experiments are carried over a long period, the more extended the better. It would be dangerous to consider the results obtained in this plot as significant.

The above observations afford a probable explanation of a problem which has puzzled most investigators dealing with this affection. In the early days of the rubber industry, when large numbers of superimposed cuts were put up the tree to a height of 10-15 ft, Brown Bast was apparently unknown. Harmsen has collected figures (Vide. Rands. 11) showing that with two superimposed cuts Brown Bast makes its appearance on the top cut first in 80% of cases. It is probable, that in the early days, the top cuts became affected with Brown Bast, but each tapping area below acted as an isolation barrier, preventing the appearance of the affection in the lower panels. Again, little care was taken in the matter of bark excision and it is possible that affected bark was removed almost as rapidly as it appeared.

The same features to which attention was directed in the previous experiments regarding the " trigger action" appearance of Brown Bast, were noticable in these plots. The figures given below show the special Brown Bast dates for Plots A and B. The quiescent period is not well marked because of the limited tapping period, but the totalled figures, as below, show that the monthly increase was fairly large, but during March and April only two fresh cases were reported. The monthly increases were :—

November.	December.	January.	February.	March.	April.
14	25	18	11	8	2

The falling-off in numbers is clearly shown by the totalled figures and indicates the typical rise and fall period already noted.

SPECIAL BROWN BAST DATES FOR PLOTS A AND B.

B. Bast dates	6-10-21.	4-11-21.	28-11-21.	6-1-22.	4-2-22.	2-3-22.
Plot A	1	4	10	6	5	6
Plot B	2	1	1	5	1	2

TABLE No. 6.

Month.	No. of trees	No. of Brown Bast trees.	No of Yielding trees.	Total Yield.	Average yield per tree per mensem	Plot.
	50	.	50	37.38	0.75	A
	50	.	50	41.63	0.83	B
1921	50	...	50	38.00	0.76	C
September	50	..	50	43.88	0.88	D
	50	...	50	45.00	0.90	E
	50	...	50	46.63	0.93	F
	50	.	50	34.38	0.69	A
	50	3	47	60.50	1.29	B
October	50	4	46	49.00	1.06	C
	50	3	47	47.88	1.02	D
	50	1	49	51.31	1.05	E
	50	3	47	50.81	1.08	F
	50	2	48	45.69	0.95	A
	50	6	44	56.88	1.29	B
	50	9	41	48.88	1.19	C
November	50	7	43	47.19	1.10	D
	50	5	45	48.56	1.08	E
	50	9	41	46.38	1.13	F
	50	...	50	31.06	0.62	G
	50	10	40	40.69	1.01	A
	50	9	41	43.13	1.05	B
	50	9	41	42.50	1.04	C
December	50	12	38	12.25	0.32	D
	50	10	40	24.00	0.60	E
	50	13	37	33.69	0.91	F
	50	2	48	24.50	0.51	G
	50	16	34	26.75	0.78	A
	50	15	35	34.94	1.00	B
1922	50	11	39	34.13	0.87	C
January	50	12	38	17.69	0.46	D
	50	13	37	24.19	0.65	E
	50	14	36	31.63	0.88	F
	50	3	47	21.19	0.45	G
	50	22	28	25.19	0.90	A
	50	16	34	36.06	1.06	B
	50	14	36	34.44	0.96	C
February	50	12	38	17.25	0.45	D
	50	13	37	27.00	0.73	E
	50	16	34	32.88	0.97	F
	50	4	46	19.50	0.42	G

TABLE No. 6—(*contd*)

Month.		No. of trees.	No. of Brown Bast trees.	No. of Yield-ing trees.	Total Rubber.	Average yield per tree per mensem	Plot.
1922 March	(	50	28	22	23.63	1.07	A
	(	50	18	32	35.63	1.11	B
	(	50	18	32	32.06	1.00	C
	(	50	13	37	19.25	0.52	D
	(	50	17	33	25.00	0.75	E
	(	50	16	34	41.25	1.21	F
	(	50	7	43	14.01	0.32	G
April	(	50	29	21	17.00	0.81	A
	(	50	19	31	29.13	0.91	B
	(	50	18	32	26.50	0.80	C
	(	50	13	37	17.13	0.46	D
	(	50	17	33	25.63	0.78	E
	(	50	16	34	27.44	0.81	F
	(	50	7	43	15.63	0.36	G

PART IV.

TAPPING EXPERIMENTS.

The previous experiments left a large number of trees which had been slightly attacked by Brown Bast. The opportunity arose to make a comparison between these and others not previously affected. The suggestion was made that a slight attack might confer some immunity, as in many human diseases.

The high-yielding "mother trees", utilised as the source from which Bud-grafts have been started in the attempt to gain trees of higher yielding capacities, usually succumb to Brown Bast. The behaviour of the slightly Brown Basted trees under further tapping might be of interest and give a line to the future behaviour of "daughter" bud grafted trees.

Another point was the endeavour of Rands (11) to develop a strain of *Hevea brasiliensis* immune to Brown Bast, the selection being made according to the behaviour of high yielding trees subjected to heavy tapping. • It has been noted above that Brown Bast trees, detected in the earliest stages, often recover after one month's rest, and show no signs of the affection on resumption of tapping. Now if any such trees should prove to be comparatively high yielders and maintain their capacity for high yielding over a fairly lengthy period after recovery, the work carried out by Rands along the lines adopted would be practically negatived.

The tables are given below, with the yield figures in ounces. The totalled yields for January in the two series show little difference.

The final Brown Bast figures show that the trees previously affected with Brown Bast devolop the symptoms more quickly than the trees which have not been previously affected. Even in these small plots, the quiescent months are noticable ; from April to September in the plot of healthy trees and from March to October in the .plot of previously affected trees.

The results, in general, show that trees having suffered from Brown Bast are more readily attacked than healthy trees and it might be expected that "daughter trees" developed by vegetative propagation from "mother trees" which show this affection will be more readily affected than others which have been developed from stock unaffected by Brown Bast. Further evidence will be offered below to show that the extremely high yielders in a plot of trees all yielding above the average, are the first to become affected with Brown Bast,

Rands methods to obtain immune trees resistant to Brown Bast, are based on trees severely overtapped (see Part 11.) *for at least two months.* Trees which do not contract Brown Bast during this period he considers may be sufficiently immune to form the parent stock from which to breed. The results from Tree No. 10 in the plot of previously affected trees, effectually undermines this basis. This tree is reopened after recovery ; continues as a comparatively high yielding tree for twelve months without a recrudescence of the attack, while trees unaffected previously, give lower yields during the twelve months, but become affected with Brown Bast. Such evidence leads to the suggestion that Rands endeavours to obtain immune trees on the basis adopted are not likely to prove successful.

TABLE No. 7.

Healthy trees.

Month.	1	2	3	4	5	6	7	8	9	10	Brown Bast trees.
Jan.	24.48	14.96	21.50	39.80	35.07	18.21	25.60	33.72	18.38	34.34	1
Feb.	16.93	7.81	18.95	34.89	24.78	*6.60	15.81	24.87	12.04	23.13	1
Mar.	17.52	11.32	17.70	38.30	25.77	*5.16	15.37	31.69	13.45	25.88	1
April	18.92	6.01*	11.67*	28.69	23.40	*4.72	11.67	17.71	10.28	19.45	3
May	26.36	9.30*	14.63*	48.81	27.79	*6.26	15.35	24.75	8.89	20.35	3
June	20.00	...	11.00*	36.00	16.00	...	12.00	20.00	8.00	16.00	3
July	24.00	...	16.00*	45.00	28.00	...	16.00	30.00	12.25	25.00	3
Aug.	26.00	...	20.00*	42.38	26.00	...	12.06	23.08	10.38	22.03	3
Sept.	23.21	...	23.21*	35.33	16.06	...	18.28	24.19	10.46	11.06	3
Oct.	21.50	...	17.44*	55.06	...	...	20.31	25.40	15.68	...	5
Nov.	7.31*	...	7.19*	37.25	...	...	16.50	20.00	17.50	...	6
Dec.	...	...	...	42.50	...	...	11.75	20.50	11.00	...	6

* Brown Bast trees still yielding latex.

296.06 Total yield in January.

TABLE No. 7—(*contd.*)

Trees with previous Brown Bast.

Month.	1	2	3	4	5	6	7	8	9	10	Brown Bast trees.
Jan.	20.95	22.44	33.60	25.74	35.10	11.42*	24.42	31.31	30.86*	44.40	2
Feb.	13.65	16.89	35.02	1.75*	41.00	.19*	22.16	28.24	2.00*	42.78	3
Mar.	14.58	16.34	21.18*	.65*	5.97*	1.07*	20.57	33.54	.19*	54.52	5
April	12.56	14.36	...	...	...	...	15.10	21.19	...	37.16	5
May	13.48	12.77	6.48*	...	...	...	26.87	15.57	3.19*	42.37	5
June	10.02	13.37	...	...	...	...	11.98	20.87	...	44.53	5
July	9.00	17.25	...	...	...	...	16.92	26.00	...	61.00	5
Aug.	11.00	17.00	...	...	...	...	19.00	26.00	...	51.00	5
Sept.	21.09	14.16	...	...	...	...	21.58	26.50	...	41.54	5
Oct.	11.00	14.50	...	...	...	...	4 25	20.30	...	53.22	5
Nov.	12.06	6.50	...	...	...	...	...	15.19	...	18.00	6
Dec.	...	...	...	...	...	...	...	12.38	...	17.19	8

* Brown Bast trees still yielding latex.

280.24 Total yield in January.

PART V.

BROWN BAST EXPERIMENTS ON GOOD AND POOR YIELDERS.

The most important feature regarding Brown Bast is the possibility of the affection acting as a limiting factor when high yields are in question. Much attention has been directed towards increasing the yielding capacities of individual trees, over the last two years, by means of seed selection and vegetative propagation. Yields of 1000–2000 lbs. per acre have been suggested as possible from "bud-grafts" developed from high yielding stock.

Little evidence had been brought forward at the time to show that high yielding trees were more susceptible to Brown Bast than trees which give less latex per tapping, though running through most of the literature was the suggestion that high yielders were more susceptible than low yielders. Keuchenius (c) has since dealt with this problem and on his results states that "the belief i e., that good yielders are more susceptible to Brown Bast, is to be relegated to the realms of myth". The terms susceptibility and immunity have been used very loosely in connection with the Brown Bast problem. *A priori*, if Brown Bast is an exhaustion phenomenon high yielders will tend to develop the affection more quickly than trees yielding less latex, under the same conditions; at the same time it cannot be claimed that poor yielding trees show a superior degree of immunity, as will be shown decisively below.

Table No. 8(a).

Yields from Poor Yielders.

Tree No.	Yield in Liq. Ozs.	Jan. 1922	Feb.	Mar.	April.	May.	June.
1	½	9.82	15.95	16.03	9.08	15.23	13.27
2	½	10.87	7.04	10.77	4.81	6.85	6.82
3	¼	8.82	8.72	6.47	1.51	6.06	3.74
4	¼	11.62	5.30	3.39	3.43	6 43	2.86
5	¼	7.82	7.91	6.95	5.69	6.95	5.29
6*	½	18.02	12.29	9.26	11.43	15.24	13.33
7*	½	16.85	16.91	14.98	5.82	4.11	...
8	½	10.51	12.51	12.31	7.74	8.77	6.91
9	½	13.57	6.51	4.84	4.16	5.58	3.86
10	½	11.49	11.89	11.16	7.72	6.82	6.62
11*	½	15.62	11.36	8.98	6.58	7.26	15.85
12*	½	15.94	12.08	4.26	4.66	4.07	...
13	¼	13.41	9.60	7.88	3.98	4.24	...
14	¼	11.46	7.42	4.88	3.63	9.36	9.61
15	½	12.85	7.95	11.00	7.74	10.98	13.36
16	½	12.63	20.91	13.50	11.35	15.19	12.89
17	¼	10.85	9.08	6.60	5.91	7.31	6.62
18*	¼	16.09	13.34	13 44	15.01	15.22	15.89
19	¼	13.01	7.25	6.15	8.84	11.16	9.26
20*	½	15.82	6.04	7.06	9.08	8.22	9.59
21	½	13.46	12.85	4.07	2.00	6.05	...
22	½	11.52	11.19	4.69	4.32	6.26	2.94
23*	½	16.71	8.65	9.67	9.10	9.14	8.25
24*	½	16.76	29.13	20.60	17.35	16.75	17.19
25*	¼	15.60	6.90	7.24	5.92	4.00	4.95
			none	none	none	none	7*
							12*
							13
							21
Totals		...	...	...	...	...	2 + 2

* Trees with over 15 ozs. of Rubber in January's tapping.

TABLE NO. 8(*a*)—(*contd.*)

Yields from Poor Yielders.

Tree No.	Yield in Liq. Ozs.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	$\frac{1}{2}$	15.00	16.09	16.13	16.38	11.50	7.00
2	$\frac{1}{2}$	7.01	7.17	10.61	...	...	...
3	$\frac{1}{4}$	6.00	6.44	10.38	9.19	8.50	8.00†
4	$\frac{1}{4}$	5.00	3.11	...	...	...	...
5	$\frac{1}{4}$	6.38	5.25	9.09	7.20	7.31	6.75
6	$\frac{1}{2}$	15.06	13.31	15.61	14.25	12.00	16.25
7	$\frac{1}{2}$	...	...	...	...	...	...
8	$\frac{1}{2}$	7.17	7.17	7.91	10.31	8.50	4.00†
9	$\frac{1}{2}$	6.00	8.11	5.64	9.38	1.00	...
10	$\frac{1}{2}$	8.63	3.31	...	...	...	...
11	$\frac{1}{2}$	12.00	12.13	8.67	...	...	...
12	$\frac{1}{2}$	...	...	...	...	...	...
13	$\frac{1}{4}$	...	...	...	...	...	...
14	$\frac{1}{4}$	11.00	3.28	...	...	...	...
15	$\frac{1}{2}$	17.28	16.02	15.35	18.63	19.06	20.00
16	$\frac{1}{2}$	20.00	17.28	16.35	20.06	16.38	7.00†
17	$\frac{1}{4}$	11.00	8.44	12.28	...	...	...
18	$\frac{1}{4}$	15.00	14.13	16.35	23.94	15.41	8.19†
19	$\frac{1}{4}$	11.00	10.06	12.41	12.43	13.06	9.00
20	$\frac{1}{2}$	9.00	8.62	10.53	12.38	9.00	7.50†
21	$\frac{1}{2}$	...	...	...	...	...	...
22	$\frac{1}{2}$	7.00	5.62	9.25	9.00	9.50	8.25†
23	$\frac{1}{2}$	11.00	10.31	11.35	15.13	8.00	6.94†
24	$\frac{1}{2}$	16.00	20.16	16.31	..	...	...
25	$\frac{1}{4}$	9.98	12.13	14.19	9.06	17.03	12.50†
		no increase	no increase	4	2	9	25*
				10	11		18*
				14	17		8
					24*		16
							23*
							20*
							3
							22
Total	...	...	...	3	2 + 2	1	4 + 4

* Trees with over 15 ozs. of Rubber in January's tapping.
† Brown Bast trees in December.

Table No. 8(b).

Yields from Good Yielders.

Nos.	Amount of latex in cup.	Jan. 1922	Feb.	Mar.	April	May	June
	Liq. Ozs.						
1	2¾	27.10	36.79	13.11	2.60	2.52	...
2	2	18.66	16.00	9.74	9.24	9.80	...
3*	2½	14.82	14.30	2 26	2.33	...	...
4*	5	15.50	10.22	2.97	8.26	26.39	9.93
5*	2	10 33	9.86	12.06	9.87	12.90	11.85
6	3½	24.90	28.80	27.05	18.98	23.95	22.46
7	2¼	22.28	27.95	3.29	2.57	6.71	...
8*	2	13.71	23.82	4.74	2.00	5.16	...
9	2	25.85	40.60	15.26	2.21	7 21	...
10	2¼	19.27	31.90	35.32	26.67	25.72	35.16
11	3	22.72	11.55	32.59	21.45	23.85	27.46
12*	3	13.07	24.77	28.50	16.82	15.83	20.10
13*	5½	13.54	13.21	11.70	8.93	17.34	7.08
14*	2¼	11.18	22.04	21.82	15.12	13.66	11 91
15*	3¼	12.81	20.86	20.58	15.17	19.61	19.86
16	2¾	17.07	32.99	36 30	28.73	28.45	24.71
17*	2	13.09	10.71	40 78	19.11	15 90	..
18	3¼	24.53	36 39	34.17	25 27	28.95	34.43
19	2½	22.00	13 38	19 33	12 86	22.86	17.14
20	2	25 39	42.14	19 77	12.20	47.57	60.20
21	2¾	20.79	17.24	22.50	16 51	17.72	18.60
22	3½	16.87	30 31	32.75	32 07	30.35	30.79
23	5½	17.06	15 72	16.62	17.37	17.19	...
24	3¼	20.98	23 25	23.77	18 08	29 35	21 74
25	2¼	21.92	18.35	8.16	4 00	...	...
			none	25	none	2	4
				3*		7	1*
						8*	13*
						17*	19
						9	
						23	
	Totals	...	...	1 + 1	...	4 + 2	2 + 2

* Trees with less than 16 ozs. of Rubber in January's tapping.

TABLE No. 8(*b*)—(*contd.*)

Yields from Good Yielders.

Nos.	Amount of latex in cup.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Liq. Ozs.						
1	2¾	...	...	...	...	...	...
2	2	...	...	...	...	...	...
3	2½	...	...	...	...	...	...
4	5	..	...	...	...	...	...
5	2	13.81	13.00	10.26	17.00	7.19	...
6	3½	22.56	28.00	25.23	28.00	30.02	12.31
7	2¼	...	...	...	...	...	...
8	2	...	...	...	...	..	...
9	2	...	...	...	...	...	...
10	2¼	32.00	39.00	39.89	42.00	40.00	17.00†
11	3	23.95	26.00	32.12	27.00	28.05	33.25
12	3	33.12	31.00	33.12	22.00	36.00	40.13†
13	5½	...	...	...	...	...	...
14	2¼	12.00	17.00	...	...	...	...
15	3¼	22.00	19.03	24.41	...	...	...
16	2¾	31.00	30.03	46.41	25.00	28.19	9.19†
17	2	...	...	...	...	...	...
18	3¼	35.00	25.03	23.01	...	...	...
19	2½	...	...	...	...	...	...
20	2	80.00	61.03	25.03	...	..	...
21	2¾	19.00	23.00	19.25	26.00	24.00	25.25†
22	3½	34.00	28.00	31.12	32.00	29.50	28.00
23	5½	...	...	...	...	...	...
24	3¼	20.38	31.12	26.31	24.00	27.00	23.75†
25	2¼	...	...	...	...	...	...
		no increase	14*	15* 18 20	no increase	5*	10 16 24 21 12
Totals ...		...	+ 1	2 + 1	...	1	5

* Trees with less than 16 ozs. of Rubber in January's tapping.

† Brown Bast trees in December.

The results of the following experiments will give some indication as to possibilities, Twenty five good yielders and twenty five poor yielders were selected from a block of 10 years old trees. The tapping system in operation was a single cut, daily, on ½ of the circumference. The trees were selected on the result of a single days tapping by measuring the yield of latex in a graduated cylinder. The trees were divided as under.

Good Yielders	...	2 ozs of latex and above.
Poor Yielders	...	½ „ „ „ „ below.

The trees were put under a Full Spiral cut immediately and at the end of the first month the yields were checked in order to see which trees could be regarded as consistent good yielders or poor yielders. The trees fell into the following groups:—

16 Good Yielders gave	...	16 ozs of Dry Rubber or over
16 Poor „ „	...	15 „ „ „ „ „ less

9 of the provisionally selected good yielders gave less than 16 ozs of Dry Rubber and 9 of the poor yielders gave 15 ozs of Dry Rubber or over. That the method of selection may be considered satisfactory for our particular purpose is shown by the great majority of poor yielders remaining poor yielders over the experimental period.

Thus there is one class of definitely good and one of definitely poor yielders. The results are given in concise form below.

	Good Yielders. (Total No. of B. Bast cases)	Poor Yielders. (Total No. of B. Bast cases)
March	2	0
April	2	0
May	8	0
June	12	4
July	12	4
August	13	4
September	16	7
October	16	11
November	17	12
December	22	20

This analysis shows some interesting pointers. The first is relative to the assertion that high yielding trees are susceptible to Brown Bast which implies that some trees, presumably poor yielders, are immune to some extent. This conception must be considerably modified on the above results though the reason for the statement becomes plain. The high yielding trees taken as a whole, develop the affection more rapidly than a similar number of low yielders, but low yielding trees are still susceptible. It will be shown later that taking the twenty-five trees which were originally included in the group of Poor Yielders, the comparatively high yielders in this group developed

Brown Bast much less rapidly than the extreme poor yielders. The difference in time-periods will be much exaggerated with a light routine tapping system, and the true state of affairs is not likely to be exposed except under heavy tapping conditions. The susceptibility of high yielding trees is more apparent than real. Though further experiments of this type are desirable, the evidence seems so clear cut that we are warranted in suggesting that the use of the terms susceptibility and immunity, as applied to Brown Bast, should be discouraged, as such use only leads to misconceptions. Our results on these lines agree in the main wtth those of Keuchenius but we cannot go so far as to agree that the belief is purely mythical. Under routine conditions without exact control, the above conclusion regarding good yielders would undoubtedly seem valid.

Further, it will be noted that the exceedingly good yielders in the first selection, Nos. 4, 13, and 23 developed Brown Bast quickly. The high yield presumably was a preliminary indication to the early development of Brown Bast though none of the three trees showed high yields after the selection was made. As pointed out above, the appearance of Brown Bast under routine tapping would be retarded considerably, and under such conditions it is probable that such trees would continue to give high yields for a considerable period without showing signs of Brown Bast, and would be chosen as "mother trees" to start selection from. The danger is obvious and further comment superfluous.

In the next group of high yielders to be considered, seven trees with 3 — 4 ozs of latex in the preliminary measurement, are included. Five of these Nos 6, 11, 12, 22 and 24 did not develop Brown Bast until December, but Nos. 6 and 12 were giving indications that Brown Bast was imminent by big variations in yield. No. 12 fell in the middle class yielding less than 16 ozs of Rubber during the first month's tapping. The striking feature in good yielding trees remaining free from Brown Bast over a long period of heavy tapping, is the steady yield over the experimental period.

If the results from the plot of poor yielders are analysed, a certain group of trees, Nos. 1, 6, 15, 16, 18, 24, will be noted as giving yields consistently higher than the remainder. All of these trees with the exception of No. 24, went through the experimental period, without developing Brown Bast. Thus had we been dealing with this plot alone, the statement could have been made that comparatively good yielders were less susceptible than poorer yielders.

The terms, susceptibiliiy and immunity, cannot be used happily in the light of the above results. Both plots show that the comparatively high yielders may resist the onset of Brown Bast to a higher degree, than trees which are yielding less latex. These facts show the danger of accepting generalisations based on comparative counts taken over large areas without the necessary experimental control.

The inference would appear to be justified that all trees yielding high above the average are likely to suffer from Brown Bast and

that trees yielding far below the average show a tendency in the same direction. It is quite possible that these two features may be connected, that the low yielding trees may have been high yielders some time previously and their low yielding may be the indication of an approaching attack of Brown Bast. The steady, average yielding trees seem eminently the most desirable and the least likely to suffer from this affection.

Much has been written regarding selection of "Mother trees," from which to obtain "Bud-Wood" for the purposes of grafting. Selection has been based on yields under routine tapping, combined with counting the number of latex rings. In the writers' opinion, little reliance can be placed on the counting of latex rings, as the exceptions to any rule are numerous, and many curious results are obtained. It is doubtful if yields under routine tapping have been continued long enough in any single case to form a satisfactory basis for selection. The table for good yielders indicates the possibility that if selection for yield and Brown Bast resistance is carried out as in our experiments the trees select themselves by their definite behaviour. Nos. 6, 11, 12, 22 and 24 are distinct in both respects, and only one single tree No. 20, could be taken into comparison. This tree gave large fluctuating yields over a 9 months period giving a total of 403.63 ozs. The Brown Bast resistant, steady yielders gave a total for 12 months of between 220 - 355 ozs., and their resistance to the onset of Brown Bast should be a strong argument for their selection as Mother trees. The suggestion may be made that experimental work of this type might result in finding the most suitable "mother trees" for selection purposes. On the basis of selection as practised up-to-date, our results lead us to think that "daughter trees" will vary in many directions and that it will be difficult to establish correlations. This seems to be supported by the latest reports from Java.

Summary of Important Features.

It will be convenient to summarise at this point the more important features noted in the preceding parts.

Part 1.

(*a*) The sudden increase in number of Brown Bast cases during certain months of the year was noticed.

(*b*) The relation between yield and amount of bark removed as observed under routine tapping systems, i.e. ¼ Spiral and ½ Spiral, breaks down when a heavy tapping system, i.e. Full Spiral, is in operation. Heavy tapping and high yielding probably may be regarded as equivalent terms.

(*c*) Suggested that under experimental conditions, it is doubtful if significant comparative results with reference to Brown Bast, can be obtained under routine tapping.

(*d*) Daily tapping compares unfavourably with Alternate Daily or any tapping system with longer intervals between successive tappings.

Part 2.

(*a*) Sudden rise and quiescent periods noted in Part 1, confirmed. Sudden increase in number of Brown Bast cases suggests "trigger action."

(*b*) Stoppage of Brown Bast extension at old "opening-up" marks in large percentage of cases noteworthy. Similarly noted that in large percentage of cases Brown Bast does not extend much below the tapping cut if spotted in the earliest stages but in 14% of Brown Bast cases the affection spreads to the base of the tree after heavy tapping in spite of resting.

(*c*) Heavily tapped, abnormal plot showed no Brown Bast over an eleven months tapping period. Sudden increase in average monthly yield is related to sudden increase in percentage number of Brown Bast cases. Continued tapping over a lengthy period with a control plot, showed a permanent increased yield and normal Brown Bast development.

(*d*) No definite connection between rainfall and Brown Bast development.

(*e*) Heavy Brown Bast periods coincide with dry periods if yield continues high during the dry period.

Part 3.

(*a*) Various features under Part 1 and 2 confirmed.

(*b*) Noted in this series that a sudden increase or decrease in yield was a fairly certain indication of an early attack of Brown Bast.

(*c*) A plot, heavily tapped during the heat of the day, showed small diminution in yield, as compared with other heavily tapped plots, tapped early. Estate practice leads to the conclusion that late tapping results in considerably decreased yields. This feature is of interest because of the Part 1, observations, where it was shown that the usual relationships observed under light tapping, break down when heavy tapping is taken up.

(*d*) Shown that wide depressions of recently renewed bark will prevent Brown Bast extension successfully, functioning in a similar manner as narrow deep cuts to the wood, as demonstrated by Keuchenius in Sumatra. Numerous dry trees developed in the two plots with isolation cuts without showing Brown Bast symptoms.

(*e*) Circumstantial evidence obtained to indicate that wounding influence is of small importance.

(*f*) Explanation offered of presumed non-occurrence of Brown Bast in early days of rubber plantations, when excessive tapping and yields were the order of the day.

Part 4.

(*a*) Shown that trees having suffered from Brown Bast are more readily readily attacked than trees not previously affected.

(*b*) Evidence obtained which provides substantial grounds for stating that Rands endeavours to obtain immune trees on the basis of short periods of heavy tapping are not likely to prove successful.

Part 5.

(*a*) Shown that high yielding trees develop Brown Bast more readily than low yielding trees, but the latter are not immune to Brown Bast. Over a long period of heavy tapping, low yielders finally develop Brown Bast, in some cases earlier than better yielding trees.

(*b*) Very high yielders develop Brown Bast very quickly.

(*c*) Important point indicated that if yield remains constant, without large variations, over the experimental period, good yielding trees remain free from Brown Bast, even under heavy tapping.

THEORETICAL CONSIDERATIONS.

The experimental data obtained in the preceding portions strongly support the view of a disease of "physiological" origin. Keuchenius (6) is the only strong backer of a "bacterial" as opposed to a physiological origin of Brown Bast. He strongly criticises the work of other investigators in presenting his own views of a probable bacterial origin of Brown Bast.

In support of this view, Keuchenius attaches weight to isolation experiments, when under the same conditions, he obtained Bacteria from bark affected with Brown Bast but not from healthy. His final inoculations were unsuccessful and the only just conclusion to be drawn was that if Bacteria are the cause of Brown Bast, he had not succeeded in isolating the causative agent. He suggests possible explanations why the inoculations proved unsuccessful, but these are unsatisfactory in view of his own statements, apart from the negative results obtained. He says (6) "If now a bark area is tapped which is connected with the affected area, latex flows from the diseased tissues to the tapping area and there is every risk that a few Bacteria are passively carried along from the border of the affected area by the latex and so cause the spread of the disease." Judging from this it appears to us that it would only be a matter of time and trouble for Keuchenius to have obtained successful inoculation results if his views are truthfully reflected by the above statement.

To quote again (6) "the negative results of the infections experiments with diseased bark and bacterial cultures is no more a disproof of the infections theory than it is an argument in favour of a physiological cause." We fail to realise the cogency of this argument, but this fact is certain, that a "bacterial" cause cannot be admitted

in the absence of positive inoculation results. All other investigators and Keuchenius himself admit the failure of innumerable attempts in this direction i.e. to show that the disease can be transmitted from diseased to healthy trees, and no side issues can be of assistance in the absence of such fundamental data. It appears to us that Keuchenius refuses to accept the only justifiable conclusions which can be reached when the whole of the Brown Bast work is taken into consideration.

Belgrave spent considerable time in repeating the isolation experiments of Keuchenius in the F.M.S. His early results were successful, but further work led him to the conclusion that Bacteria could not be isolated from Brown Bast tissue if sufficient care was taken to maintain sterility during the initial operations. This conclusion does not influence the results of Keuchenius along this line because the latter's controls with healthy bark remained sterile.

Keuchenius suggests that these Bacteria probably inhabit the latex vessels in small numbers, but no other elements of the cortical tissues are invaded. During the spread of the disease the Bacteria can only pass along the latex vessels. To support this, he instances the results of isolation cuts used for limiting the area of spread of the affection on individual trees. He also states that resting or discontinuance of tapping affects restriction of the disease to the infected area. He says (6) " This latter is easily understandable, as spread of the disease in a chronic stage can only occur when healthy latex vessels, which are in contact with diseased, are opened, so that latex flows therefrom." This statement cannot be held in its entirety in face of the careful checking in our experimental plots, which showed that 14 per cent of Brown Bast cases artifically developed on the cut continued to spread to the base of the tree after tapping was stopped.

With reference to the importance of isolation cuts in the theoretical consideration of the cause and the presence of Bacteria in the latex vessels he says :—" This shows that healthy and diseased parts of a bark layer cannot be connected again if they have been separated by an isolation cut, and that in consequence no further spread can occur." This statement refers not only to deep isolation cuts made to the wood, but also to cuts which do not reach the cambium, but go deeper than the infected layers. On Part 8 experiments show that this statement does not meet the case for the affection travels easily over a narrow isolation depression of ½ an inch at ordinary tapping depth and occasionally across a wide depression of 1½ inches.

There seems little support remaining to enable Kechenius to maintain his " bacterial " theory. We have now to deal with the arguments he arrays against the acceptance of a " physiological " theory, but it will be advisable to consider various points relating to the physiology of *Hevea brasiliensis* before doing so.

It is usually assumed that the physiological functions of *Hevea brasiliensis* proceed on normal lines ; all analogies respecting physiological function are based on this normality of the rubber tree. Ringing experiments carried out by this Department, show conclusively

that ringing by excision of cortical tissues, sufficient to ensure total interruption of elaborated food materials from above downwards through the bast elements, does not result in the death of the tree. Trees ringed in 1917 were still alive in 1921 since when the gap in the cortical tissues has been bridged and the trees are now carrying on normally. This feature has been reported from Uganda also. Further, experiments have been conducted by Belgrave with trees tapped over the whole circumference (Double V) at varying intervals and careful microscopic examination does not reveal any abnormality. There seems to be no undue interference with important food currents, although the circumferential tapping probably results in the cutting of healthy sieve tubes, outside the innermost cortical layers which are not excised during tapping.

The deduction to be made is that the sieve tube elements in the cortical tissues of *Hevea brasiliensis* are not of the same importance for food transport as in other plants, or that there is an alternative route for transport of elaborated food materials under abnormal conditions (i.e. when tapping). Dixon and Ball (3) have drawn attention to a similar possibility in plants with large underground storage organs, such as the potato, and have expressed the opinion that diffusion in the bast is inadequate to account for the observed rate of transport of carbohydrates in plants. Thus *Hevea brasiliensis* under plantation conditions, is probably one of a class of plants which must be considered physiologically abnormal, when compared with the majority of plants.

There is support for the above remarks. We have demonstrated that "Phloem Necrosis" or lignification of the sieve tubes is a common feature in the cortex of *healthy* rubber trees which are being tapped. "Phloem Necrosis" is a special feature of certain diseases of plants, the best known being that demonstrated in the potato by Quanjer (9). *These diseases can be easily transmitted from an infected to a healthy plant.* Farmer and Horne (4), suggested that Brown Bast was a type of "Phloem Necrosis," but we dissent from this view as we have plots of *healthy* trees under comparative experiment which were separated and are being compared according as to whether they showed "Phloem Necrosis" or not. The possibility may be suggested that non-functional sieve tubes become lignified. These facts are strong evidence for suggesting that the ordinary functions of *Hevea brasiliensis* should be considered as deviating from the normal, and experimental evidence obtained should be considered from this standpoint,

Further, the latex vessels of *Hevea brasiliensis* when tapping is in full swing, must be considered of great importance when discussing physiological problems of *Hevea brasiliensis*. The latex vessels of this plant contain substances of high osmotic activity, and when the water balance is disturbed as during tapping, (latex contains about 60% of water by volume under routine tapping conditions) the latex vessels must exert a strong water drawing influence upon the surrounding cortical tissues, in order to replace that which is lost. It is not difficult to visualise that loss of water as a result of excessive extraction of latex would bring about a critical stage, when the usual

physiological relations would break down and bye-products would accumulate in the cortical tissues within the sphere of influence to be reflected as Brown Bast symptoms.

The working hypothesis based on the theory of "physiological" origin was the probable importance of the tapping operation. A fair amount of general work had indicated the fact that high yielding trees often became affected with Brown Bast and therefore the possibility that excessive yielding was the prime factor in the inception of this disease. Little controlled experimental work had been done to separate the two important factors in the tapping operation :—

(*a*) The influence of wounding owing to the cutting by the knife.

(*b*) The influence of excessive withdrawal of latex.

It is unnecessary, at this point, to repeat the various features of importance observed during our long term experiments which directly support the view that withdrawal of excessive amounts of latex are of first importance, while wounding during the tapping operation plays little, if any part.

Accepting a "physiological" explanation we have to attempt to find a satisfactory explanation for the abnormal conditions which initiate Brown Bast symptoms When considering excessive yielding as the prime factor, there are two possibilities :—

(*a*) The importance of the solid constituents of the latex.

(*b*) The importance of the liquid constituents of the latex.

Many writers have suggested that if excessive yielding is a factor of importance, exhaustion would follow as a result of loss of elaborated food materials supplied by the leaves. We have indicated above why this feature is probably of less importance than might be expected but there are two further points which prevent the acceptance of this view. Our knowledge of the loss of food materials by extraction of latex is based on coagulation results, comparing total solids after coagulation as against total liquid. Regarding cacaochouc content Belgrave found that if equal quantities of Brown Bast and healthy bark are extracted as thoroughly as possible with petrol, no significant differences can be obtained ; in some cases more rubber was extracted from Brown Bast than from healthy bark. Therefore as far as cacaochouc content is concerned there is no difference in amount of elaborated food materials stored in Brown Bast and healthy bark.

The second point is that in excessive yielding the percentage weight of coaguable content is always low or remains low for considerable periods of time, as compared with percentage cacaochouc content extracted under a light tapping system, which means that the percentage volume of water is comparatively higher. We have pointed out above the importance of the water drawing capacity of the latex vessels upon the surrounding cortical tissues and under heavy tapping conditions it is not difficult to realise the importance of this influence

when we consider the increased supplies of water demanded from the cortical tissues, not only because of the increase in quantity of latex extracted, but because of the large increase in percentage volume of water in the extracted latex. We consider this abnormal strain, placed upon the water transmitting mechanism in the cortical tissues, when excessive latex extraction is in operation, as the primary reason for the appearance of Brown Bast symptoms.

We can now consider the points which Keuchenius argues are not sufficiently explained by a "physiological" theory. He constantly refers to the failure to increase the number of Brown Bast trees in experiments of tapping to exhaustion. In view of the work detailed in the preceding parts it would be difficult to discuss the position, but we have further experiments in hand which suggest that Keuchenius may have some reason for his statement though the experiments with which he supports his view are far from satisfactory (Vide Part 11). It is impossible to form a correct judgment from single plots, tapped over a short experimental period of 30 days. Our Part 11 experiments show one plot which remained free from Brown Bast for 11 months under heavy tapping and we have other single plots now under experiment which are behaving similarly. These latter are on a better mechanical type of soil, and their behaviour brings support towards our view of the water relationships being of primary importance in the Brown Bast problem. The exhaustion experiments carried out by Keuchenius and other investigators were of short duration and the experimental methods too exhaustive and gave the trees no chance of imitating the growth conditions under which Brown Bast appears normally.

Keuchenius points out that "interruptions of metabolic assimi-
"lation provide an impossible explanation, because the worst
"interruption and simultaneously the severest exhaustion would be
"expected in the wintering season, when the yields of the trees decrease
"and reserves are consumed by the formation of new leaf. The facts
"however prove that during this period which coincides with the dry
"season the disease percentage falls." This directly supports our views; by the reduction in yield the trees are afforded some measure of protection against Brown Bast attacks and so a fall in the disease percentage might be expected. The wounding influence during the wintering period remains the same, further evidence to support our view that in the problem of Brown Bast as related to routine tapping, the wounding influence is of small significance, if any.

He says further "Another fact of importance which cannot be
"explained by the physiologists, namely the Metastase. Physiological
"theories, whether based on exhaustion, wound reaction or metabolic
"interruptions may explain that Brown Bast will not spread
"when the tree is rested (our results show that under certain condi-
"tions, in a fair percentage of cases Brown Bast spreads even if the
"tree is rested), but it remains inexplicable that the spreading may be
"prevented by isolation of the affected area, though the tapping is
"continued outside thereof. For if exhaustion, wound reaction or
"interruptions of nutrition were the cause, the cutting of isolation
"channels would further aggravate the supposed causes and the

"disease would reappear immediately (sic.) on a new tapping surface. "*That however, does not happen* which proves that the physiological "theory fails in many respects." With reference to the cutting of isolation channels aggravating the cause, increased wounding will have little effect, according to our evidence. Interruptions of nutrition are probably of little importance as respects the transport of elaborated food materials for reasons given above. The third objection that exhaustion does not account for the peculiarities observed depends largely on what is meant by exhaustion. Accepting our explanation of the water relations being of primary importance, this objection cannot be upheld. We have, at least, shown that previously Brown Basted trees develop the affection more rapidly than normal trees, so that even if the reappearance of Brown Bast on a new tapping surface after being isolated by deep cuts is not so immediate as to satisfy Keuchenius's demands, they still retain their capacity for an early appearance of Brown Bast. Further to our views, the water relationships in the cortical tissues are purely local and any degeneration would be progressive, one individual cell affecting its nearest neighbours just as the water transfer is from cell to cell according to the osmotic balance. Therefore there is no reason to expect that Brown Bast will reappear immediately on a fresh tapping surface after an affected panel has been treated by an isolation cut. Local progressive degeneration would certainly be prevented by isolation cuts made in healthy tissue below the diseased area. Moreover, rapid or slow spread would depend largely on the individuality of the tree.

Most of his arguments run on the same lines and seem to be based on general observations which have been obtained by various investigators over large areas or on experimental plots which have not satisfied the requisite conditions. Many of our results are in line with those of Keuchenius and had he accepted the negative results of his own inoculation experiments probably he would have seen the explanation which satisfies most of the information obtained. There is only one other matter to which he attaches importance and to which we offer objection. He strongly emphasises the results he obtained by putting horizontal tapping cuts on 76 trees and then covering the cuts thoroughly on alternate trees with thick strips of cotton wool soaked either with a 0.1% solution of Mercuric Chloride or with dirty ditchwater. In 30 days 8 out of 37 trees with the cuts covered with the ditchwater soaked cotton wool had Brown Bast while only 2 of the 37 trees with the disinfected cuts showed Brown Bast. He considers that this experiment strongly supports the infection theory and also explains the influence of light and moisture. Apart from the two disinfected trees getting Brown Bast, all our experiments show that such differences are to be expected in individual plots, and it was because of differences of similar magnitude that in all tapping experiments a three monthly period of preliminary experimental heavy tapping with all the plots to be compared was considered absolutely necessary before any conclusions could be drawn from the final results. In any case such experiments seem to be leading a long distance away from the important point in this problem, which is the development of this affection under ordinary tapping conditions.

Sanderson and Sutcliffe (13) in an appendix referring specially to "Dry Trees" emphasise the importance of the latex vessels in the water economy of the cortical tissues. Their explanation for the phenomenon of "Dry Trees" is practically on the same lines as the one we offer for the appearance of Brown Bast symtoms. They apparently regard "Dry Trees" and "Brown Bast" trees as representing two distinct classes of phenomena and say "A tree may quickly recover from temporary dryness by resting, if Brown Bast is not present; when the dry condition, either partially or wholly, is due to Brown Bast, no such recovery results by resting."

Our results are in complete accord with those of Keuchenius (6) on this point and show that in the great majority of cases, if Brown Bast is spotted early, resting for a month is sufficient to enable the tree to recover, but if tapping is continued and as a result, the affected portion allowed to increase until a large area is involved, a progressive series of phenomona follow, the end result of the series being the formation of "Burrs" "Dry Trees" may be regarded, in our opinion, as a half-way stage; the trees go "dry" and this refusal to yield affords them a measure of self-protection against the approaching symtoms of Brown Bast. The behaviour of Plot A and Plot G in our Part III experiments, in which comparatively large numbers of "Dry Trees" appeared without definite Brown Bast symptoms, supports this view. The bark areas being tapped above isolation cuts begin to give latex yields which decrease rapidly as the tapping cut comes within two inches of the isolation cut, most probably owing to the failure of water which should have been supplied to the latex vessels by the adjacent cortical tissues A similar explanation satisfies for the number of "Dry Trees" which usually appear during the wintering season.

Thus if the observations of Keuchenius and our own regarding the efficacy of resting trees suffering from slight attacks of undoubted Brown Bast are accepted it will be seen that Sanderson and Sutcliffe's view agrees with that presented in this paper; at least no hard and fast line can be drawn to separate Brown Bast trees and "Dry Trees" on the basis they adopt.

A 'physiological' theory is the only one which covers the experimental observations. We have observed a direct correlation between increase in yield and increase in percentage number of Brown Bast cases and shown further that Brown Bast may increase during dry periods, so that the influences of Rainfall and Moisture are not of supreme importance. In all our heavy tapping experiments on Castleton the differences were sufficiently large to prove the statement that the number of Brown Bast cases under heavy tapping or excessive yielding increases out of all proportion to the extra amount of dry rubber obtained. This in itself indicates that the water content of the latex is of more significance in the initiation of Brown Bast symptoms than the dry rubber content.

A strong argument comes up in our Part 5 results, where we showed that "Bad yielders may develop Brown Bast more readily than comparatively good yielders", and that the significant feature of

trees remaining free from Brown Bast under heavy tapping was the steady, non-fluctuating yield over the experimental period. The steady yield, high or low, indicates a balanced condition for the physiological activities of the tree and as long as the balance is maintained, there appears to be no excessive strain. As the junior author noted in the field, a sudden increase or decrease in the yield was a practically sure indication that a Brown Bast attack was imminent.

Fluctuations in yield mean considerable interference with a balanced condition in the water transmitting tissues associated with the supply to the latex vessels and this may bring about an abnormal condition which finally leads to the production of bye-products not usually associated with the healthy activities of the cortical tissues.

The sudden rise in percentage number of Brown Bast cases is difficult to explain and no suggestions can be made without further confirmatory experiments. It might be mentioned that these field experiments were under the supervision of three different officers during the four years experimental period and all reported the same phenomenon.

Recent work on phytopathological problems has brought into prominence the importance of a stable water balance if a healthy condition is to be maintained. Recently Mason (7) working on 'Die-Back' of Limes in Montserrat, a very serious disease, cautiously concluded that rapid and repeated fluctuations in the water supply of the growing tissues is at least as important a factor as any other in causing 'Die-Back of Limes' A similar explanation has been suggested for shedding of Cotton Bolls in the West Indies. It is becoming recognised more and more, that important as insect pests and fungus diseases are, the physiological condition of the host plant is often the first factor in the incidence of the disease.

A cautious attitude regarding the interpretation of the data obtained in our experimental work must be maintained but we feel some confidence in so far as the evidence obtained by Keuchenius runs on much the same lines as that contained in the present investigation. So far only the fringe of this complicated subject has been touched and for a complete explanation team work is a necessity. A close examination of soil conditions, correlated with experimental tapping and histological work would undoubtedly give much invaluable information, but pressure of other work prevents us carrying on except in regard to small details.

Investigations in Relation to Planting Policy.

The period covered by the experiments has been noteworthy because of the attention given to the possibilities of increasing individual yields by seed selection and bud-grafting. As bud-grafting has been shown to be easy and successful of operation this method has been mostly used and in cases on a large scale.

The production of high-yielding trees by artificial breeding joins issue with the probability of high yielding being the prime factor in

the cause of Brown Bast. This brings up the vital question of disease probabilities in future generations of trees which have a definitely higher yielding capacity than the parent trees.

We do not intend to deal fully with the disease aspect in relation to future production in high yielding trees: this has been done in a previous article (15). A brief sketch may be given here.

Higher yielding trees will have physiological activities of a different order than present day trees so that present day behaviour gives us a doubtful guiding line. This may be pointed in many cases by the results obtained in our tapping experiments, if we assume that the high yields obtained by heavy tapping under present day conditions will be equivalent to the possibly higher yields to be obtained under a lighter system in the plantations developed by vegetative reproduction. Part I shows that the usual relationships observed under light tapping systems does not hold for a heavy tapping system; Part III shows an experiment indicating a similar feature when tapping at mid-day showed very little decrease compared with similar tapping early in the day. With reference to Brown Bast experiments, under routine tapping, Keuchenius strongly emphasises the fact that resting the tree will result in the disappearance of the symptoms, whereas under heavy tapping, a fair percentage continued to spread, despite resting.

These facts indicate that it is doubtful if we can assume that objections to the policy of developing high yielding trees by vegetative selection will, with care in the future, be easily overcome. Such dogmatic statements are not helpful in the least. The facts are as follows: —

Rubber planting has been rendered unprofitable in British Guiana owing to the attacks of a leaf fungus. This species of fungus has not been recorded in the Middle East but close relatives exist.

Leaf-fall in Burma and Ceylon, caused by *Phytopthora Meadii*, causes large losses of crop. Up-to-date, leaf fall due to this cause is unknown in Malaya.

All phytopathologists are aware of the delicate balance of conditions which determine attacks by fungi. There are many cases of crops being attacked in one locality, and a locality near enough to be infected and growing the same crop, is free. There is no definite evidence on which to base any explanation in many cases, though in others such phenomena are definitely connected with early sowing, late flowering—the plants growing and producing their crop during periods unfavourable to the growth of the fungus.

This delicate adjustment of conditions can be well illustrated by Malayan experience. Black Stripe was considered a serious disease in 1910 in Ceylon and Java, but no evidence of this disease was found in Malaya until 1916. Now this disease regularly appears as epidemic in certain areas in Malaya where climatic conditions favour the development of the fungus. No adequate reason can be adduced for

the long immunity enjoyed by Malayan estates in respect of Black Stripe disease.

Again in 1916 Mouldy Rot made its appearance. No records of the causal fungus in Malaya (*Sphaeronema fimbriatum*) existed previously and though since recorded in Java, Ceylon and India remain free. The disease is becoming widespread throughout Malaya and although we have no definite evidence, the indications lead us to suspect a definite increase in virulence.

It is obvious that such abstruse matters can only be guarded against with the greatest difficulty and if similar phenomena which favoured a disease difficult of control were in evidence the chances are enormously in favour of the disease causing organism. It follows from the phytopathological point of view that all tendencies towards increasing the chances of fungi for attacking rubber trees should be strongly discouraged.

As we have indicated, conditions favourable or unfavourable for development of disease-causing organisms do not remain stable. It is quite possible that certain small changes in atmospheric conditions resulting from the opening up of large areas of rubber, with the consequent cutting down of jungle, have been primarily responsible for the appearance of Black Stripe and Mouldy Rot diseases. These small changes in atmospheric conditions are continually taking place and combined with any tendency towards progressive favoritism for fungal attacks, are decidedly to be guarded against.

There is little doubt that the policy of developing high-yielding trees will give a strong bias towards rendering the leaves of *Hevea brasiliensis* more liable to attack from fungi ; to this should be coupled the fact that high yielding stands will contain a less number of trees per acre, so that losses of single trees could not be viewed with equanimity. Further, it is difficult to conceive of successful spraying operations owing to mechanical difficulties even if we disregard expense. These facts taken into consideration with the not too satisfactory records from Bud-grafted trees and the experimental evidence brought forth in this bulletin to show that yields and Brown Bast are definitely connected lead us to think we are justified in preaching caution and insisting that vegetative production of high-yielding trees is still in an experimental stage. The justification for this attitude is amplified by the extracts following this article, from recent lectures given by two of the leading scientists in Java, who have been investigating the possibilities of propagating higher-yielding trees.

Treatment.

This question need not be dealt with in detail here. Descriptions of methods so far practised i.e. light scraping and tarring, deep scraping and tarring, stripping, can be found in other publications (2) and (11).

Stripping has been favorably considered by some investigators and a complete and detailed account can be found in Sanderson and

Sutcliffe's recent work (13). This method is of considerable utility, when small portions of affected bark have to be removed.

Our investigations confirm those of Keuchenius and show that under present day conditions, if careful supervision is given and every effort made to spot Brown Bast as early as possible, in the majority of cases resting for a month is sufficient to arrest the spread of the disease. If an area of bark of any extent is involved, the affected area should be isolated by deep cuts to the wood. This method was tried early in 1918 by the Brown Bast Investigation Committee in Malaya, but it was reported that boring beetles attacked the tree through the dying patches of affected bark, and the method did not find favour. Evidently this objection has not proved a serious one in Sumatra, but it is probable that attacks of boring beetles might interfere with the success of this method in Malaya, when practised on a large scale. Up-to-date the senior writer has not observed boring beetles entering bark patches of Brown Bast affected tissue when isolated by deep cuts, but some previous work (15) indicates the possibility of this happening. There has been little opportunity to test this method over the last four years, since restricted yields have been the order of the day, so a definite opinion, for or against, cannot be given. However, we are of the opinion that deep isolation cuts will provide the most effective method, combined with economy, of preventing the extension of Brown Bast in affected trees.

Summary.

(1) Evidence obtained from prolonged tapping experiments is strongly in favour of the "Physiological" origin of Brown Bast.

(2) Evidence shows that over-extraction of latex is the most important factor in initiating Brown Bast; no definite correlations have been established as between other factors *i.e.* rainfall, etc.

The authors wish to acknowledge their indebtedness to Mr. W. Malcolm Miller who officiated as Assistant Mycologist for some months and did much recording work; to Mr. T. D. Marsh, who took charge of Castleton Estate when the junior author went on leave. We are specially indebted to Mr. W. N. C. Belgrave, Plant Physiologist, who not only aided the work by constant discussion and suggestions but placed the results of much unpublished work at our disposal.

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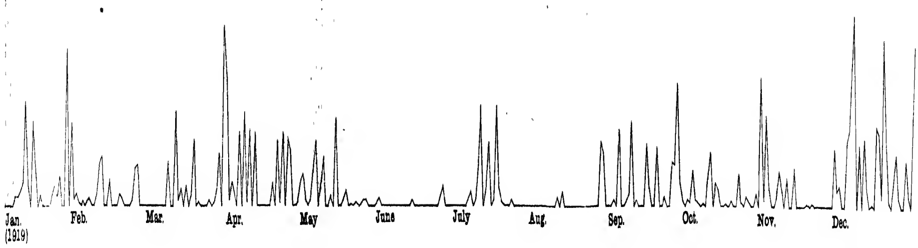
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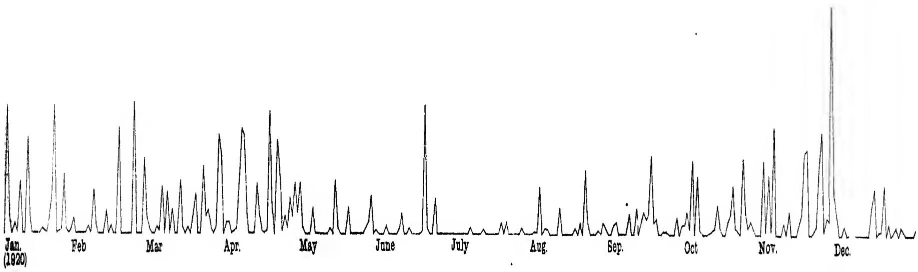
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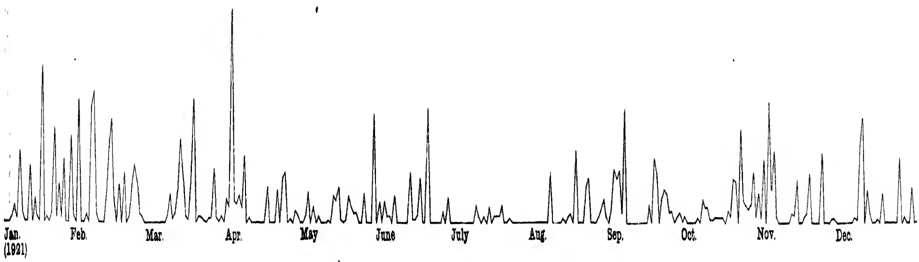
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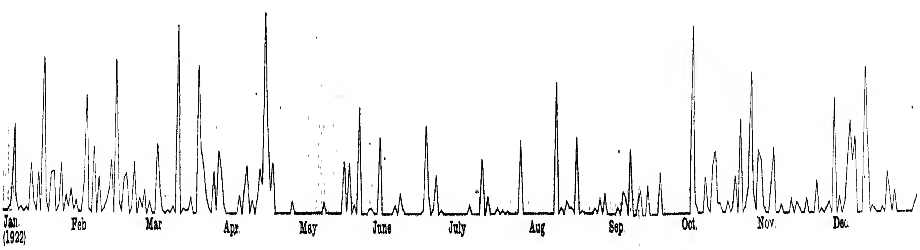
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HEVEA SELECTION.

EXTRACTS FROM RECENT LECTURES

BY

DR. C. HEUSSER AND DR. P. J. S. CRAMER.

THE following is extracted as printed in the Archief Voor de Rubber Culture —Juli 1924, Dr. Heusser's concluding remarks are as follows :—*

Concluding remarks.—"This concludes the present position of Hevea selection in our experimental station."

"You can see that we have been able with the co-operation of the estates to begin selection work with a liberal supply of starting material and we have approached the problem from different sides, perhaps you got the impression that we have started studying too many problems at the same time. I can well imagine, that at first sight it would seem better to take each question separately and to solve it by large simple experiments with large control plots. With annual crops this would be the correct method, with a perennial tree cultivation like the Hevea tree, *where furthermore the selection work is still at an elementary stage*, we must take other steps. To be able to accomplish something in a life time it is necessary to start with a large number of trees, and the experiments for the explanation of the questions should be accumulated. In this manner it is possible that unnecessary work may be done, yet time is saved. To begin with the experiments should not be too extensive, each large selection experiment takes so much space and is so costly that it must be ensured that the plantation can be worked later on. A failure in a tobacco field can be cleared away in three months, a selection garden of Hevea must however become a tapping field, and at worst it must not become inferior to an ordinary plot. We started in the first place with the aim of working out the problem as quickly as possible by small many sided experiments and have now come to a point where practice can already with advantage make use of the results obtained. We possess mother trees whose bud-grafts will give a much higher yield than the present plantation trees. Further we know that selected seed also will recompense the costs and trouble expended, by giving a higher production, and we have signs which indicate that we will shortly be successful in isolating a high yielding race. *The time has now come for making thorough experiments on a large scale.*"

Interesting results from Bud-grafts are given by Dr. Heusser in the following paras :—

"Up to the present time bud-grafts from 30 different mother trees were tapped. As was to be expected, not all of them proved to be

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*Note. Italics mine (A.S.)

good ; the productivity of the sundry clones was very different. We divided them into three groups, according to the results of the first tapping experiments.

I. Clones which are expected to yield more than double the yield obtained from unselected seedlings of the same age. These are A. V. R. O. S. mother trees Nos. 33, 36, 49, 50, 52, 80, 152.

II. Clones which are good but from which for different reasons we await further data until we definitely pass them or not. To these the following numbers belong ; 31, 35, 60, 65, 74, 93, 135, 139, 142, 144, 147, 151, 163, 174.

III. Clones which we have rejected and which were eliminated. Of a few only, a small number of trees are being retained for scientific purposes. Those rejected were Nos. 8, 9, 23, 51, 71, 149, 150, 82.

To confirm the results of the first tapping experiments and to ascertain the increase of production, the clones of the first group and also, part of the second group were tapped regularly every alternate month since the beginning of this year. The results will be published in detail in due time. I want to demonstrate to you some of the latest results. Clone 50, seven trees, 5 years old, gave an average of 16.83 grams per tree per day in January (16-30 Jan.)

I have the last monthly tapping results here (February) from our very best developed bud-graft, No. 16 of Clone No. 80. The yield for 20 days is an average of 24.4 grams per day ; you can see what respectable little sheets they are.

Clone No. 33 (10 bud-grafts) gave an average of 12.4 grams in January. If we make a comparison between the yield of bud-grafts from No. 33 with the December yield of the illegitimate seedlings from No. 138 then this is by far in favour of the bud-grafts, in spite of the fact that they are a year younger."

The following are extracts from a lecture by Dr. Cramer.

The danger of mistakes.—"It is evident that during the planting mistakes have been made, and probably during the budding also. It is not my purpose to pass over this case ; for by paying some more attention to it one can learn a useful lesson from it. He who has layed out pure plantings will know how easily such mistakes are made and how difficult it is to prevent them. The conclusion I will draw from it is in the main : *for a practical planter it is generally very difficult to lay out pure plantings from different numbers.* We cannot take enough precautions to prevent mistakes ; by marking with bamboo sticks ; by budding of each number on its own seedling bed, planting the different numbers on successive days and such measures we can work in that direction. And the second conclusion is as follows : Arrange everything so that later a careful botanical investigation can be carried on and if necessary the figures again can be classified. This will be possible by measuring the yield per lowest unit *e.g.* per tree. So we could correct

all figures, which in our tables were worked out in averages and after the trees primarily had been identified, calculate them again and classify them in the right way."

"I will call your attention to one other source of mistakes. It occurs that the scion dies immediately after the planting and the stock grows a sucker, which, when the plant is not examined carefully may easily be supposed to be a growing budding, even on already older plants on which the sucker with its smoother and different coloured bark at first may contrast with the stem of the stump. Expecially with the scions planted between green manures, which hide the lower part and make difficult the exact examination of the trees, there is a danger for such impurities. Therefore I should advise everybody: examine your planting of buddings, plant after plant and look out for suckers of stumps. Especially in the experiment garden in the Lampongs we several times were able to discover these impurities."

Finishing discussion.—"We have reviewed here the most important data obtained by studying our Heveas in the first year of tapping. As much as possible I have kept to the facts, leaving out discussion of the advantages and disadvantages which buddings may have over seedlings. I have tried to publish sufficient details for the planter to enable him to consider these advantages and disadvantages himself. Our material is not abundant, *we have only an experience covering one year*, so it seems to be possible that when there will be more data available we will have to revise our opinion on some points. This seems to me less prejudical than to leave different points undiscussed which even can make us better acquainted with the development of budded trees."

"*The best thing to do by far, is to start this work on a small scale* and to plant a field of buddings even when it is only possible on a small scale . . . . Another thing to call your attention to is, that some of the trees in the 'Cultuurtuin' deserve very much to be used for experiments with buddings, especially because we already know that their buddings give very satisfactory yields. Some time ago I brought together in the Experiment Garden in the Lampong's a good number--some times of buddings, from high yielding Heveas in West, Central and East Java. Only a very few of them appeared to be superior as budding. A typical warning example shows tree Bg. which in the plantation was known as a very high yielder. The tree stood absolutely isolated; undoubtedly this favourable condition has had a great influence upon the yield. Afterwards the buddings do not appear to be peculiarly high yielding at all. *It is not at all sure that all numbers—if we make buddings from our best yielders-will give high yields.* If one wishes to do something in this field and to look out for high budding numbers, then first of all descendants from each mother tree must be kept together and separated from those of the other trees. Only in this way a good idea about the quality of the mother tree for the growing of high yielding buddings can be formed."

"To judge whether a number is fit for budding mothertree we must not only direct our attention to the yield of it. Other characters

too must be taken into consideration. Besides a high yield a fast growth and also a conical stem are generally desired, both in connection with an early production; another desirable character is resistance against brown bast disease. . . . . ."

"Until now I have kept to figures and facts. We used them as data for comparing the advantages and disadvantages of buddings against seedlings and we tried to call your attention to a second point:—the greater uniformity of buddings certainly a marked advantage for the plantation work. But the budding process contains still many more possibilities.

"In the 'Cultuurtuin'; we already succeed in budding on each other very different species of Hevea. We also know that scion and stock have an influence upon each other while they may differ in many respects. The possibility of bringing together by budding, parts of trees belonging to different species enables us to build up Hevea trees of which root and stem have characters which meet special requirements, especially as to the soil."

"Many hereditary characters slumber in the cells of the wild Heveas in the virgin forests of the Amazon basin. These characters can be put in service for our general purpose:—to decrease as much as possible the sacrifices of labour and capital necessary for getting a ton of rubber. Once I had the opportunity myself to make a grab in that treasure chamber of nature. I got several new varieties of *Hevea brasiliensis* and some other species of Hevea. They begin now to fruit so they can be used for further multiplication. We are now starting further budding experiments with them.

"*Meanwhile all this is only in the beginning* When our work will be somewhat further I hope to meet you in the 'Cultuurtuin' again to discuss the results."

In several articles relating to Bud-grafting and allied work, other workers have referred to the critical attitude of the writer and his colleagues towards this question. Our criticisms have never been inspired because of studied opposition, but merely with a desire to maintain the correct scientific attitude and if possible to point eventualities. That our criticisms were valid is obvious from the quotations given above. We have pleaded that great care must be observed if reliance has to be placed on results—a point stressed by Dr. Cramer, in his references to the danger of mistakes; that the work was still in the experimental stage, (—a necessary and invaluable experiment but —an experiment,)—a point stressed by Dr. Heusser in his "The time has now come for making thorough experiments on a large scale, and by Dr. Cramer—"Meanwhile all this is only in the beginning.'' The disease aspect is obvious to all scientific workers, and with reference to Brown Bast both Dr. Heusser and Dr. Cramer evidently realise it as a factor of importance; the wider aspect of probable new diseases should not be forgotton however. It was pointed out early in 1923 by one of the officers of this Department (W.N.C.B.) that if any success is obtained, it will only be from a limited number of mother trees which bud true as regards yield and advice was given to Malayan

estates contemplating budding to lay down test plots of say 1 acre each. Dr. Cramer gives similar advice. The value of this advice is reflected in Dr. Heusser's results; out of 29 mentioned he could select 7 clones only which definitely could be said to have all the necessary advantages. Our attitude can be summed up in the words of the Plant Physiologist (Mr. W. N. C. Belgrave) in a lecture given at Malacca in July 1922. "One point is certain, work must be undertaken in Malaya without delay. The only test is that of growth and tapping, a matter of six years at least—this sorting out of mother trees should be undertaken soon, so that should bud-grafting prove successful we may not be left behind."

How far do the results presented in the lectures of Dr. Heusser and Dr. Cramer meet this attitude? Dr. Heusser gives results of only 11 tappings but says the results will be published in full detail in due time. The tappings were started at the beginning of 1924 and the lecture delivered on 3rd March 1924, so that only two months tapping records could be available. There is no wish to make destructive criticism on such a point, but it is patently obvious that longer tapping records are necessary before any sound conclusions can be drawn.

Relating to questions of yield one other point may be made. The general growth conditions will impose a limit upon ultimate yields, so that cultivation in the form of manuring etc. must be undertaken if yields are to be unlimited. At what point will this limit be imposed? Attention may be drawn to the $\frac{3}{4}$ Spiral plot in the preceding article which over a tapping period of 26 months gave an average monthly tree yield of 1.34 lbs. Assuming 100 trees to the acre and tapping daily, a total of 1608 lbs. per acre is realised. If unlimited yields are desired, tapping systems can be devised on present day trees in Malaya which would give astounding yields if the health of the trees were not considered. Thus the vital distinction in bud-grafting work is the question of resistance or non-resistance to disease *i.e.*, will Hevea bud-grafts give higher yields and maintain the disease resisting capacity of present-day trees. As we have pointed out—there is no definite guiding line;—only experiment can give us information, and there are indications that the disease factor may come to be considered of major importance.

A. S.

LONDON MARKET PRICE LIST, 3rd QUARTER 1924

Oil Seeds.

Castor (Bombay)	-	£29.7.6 per ton.
Copra (Ceylon)	-	£31 ,,
Do. (Straits)	-	£29.17.6 ,,
Cotton (Egyptian)	-	£13.2.6 ,,
Do. (Bombay)	-	£11 ,,
Croton	-	27/6—32/6 per cwt.
Desiccated Coconut (fine)	-	40/6 ,,
Do. (medium)	-	40/- ,,
Do. (coarse)	-	44/- ,,
Gingelly (Chinese)	-	£26.7.6 per ton.
Groundnuts (Gambia, undecorticated)	-	£19 ,,
Do. (Chinese, decorticated)	-	£25.5 ,,
Linseed (Bombay)	-	£22.12.6 ,,
Do. (Plate)	-	£20.3.9 ,,
Palm Kernels (West Africa)	-	£20.15 ,,

Oils.

Castor (Madras)	-	74/6 per cwt.
Do. (pharmaceutical)	-	78/- ,,
Do. (1st pressing)	-	73/- ,,
Do. (2nd pressing)	-	71/6 ,,
Coconut (Cochin)	-	58/- ,,
Do. (Ceylon)	-	47/3 ,,
Cotton seed (Egyptian, crude)	-	44/- ,,
Do. (Bombay)	-	41/6 ,,
Groundnut (Oriental, crude)	-	48/- ,,
Do. (English)	-	49/- ,,
Linseed (Calcutta)	-	42/- ,,
Do. (Plate)	-	41/- ,,
Palm (Lagos)	-	£39.10 per ton.
Do. (Sumatra)	-	£36.2.6 ,,
Palm kernel	-	42/- per cwt.

Oil Cakes.

Coconut	-	£10.10	per ton.
Cotton (Egyptian seed)	-	£9.—£9.5	,,
Do. (Bombay seed)	-	£8.5	,,
Groundnut (undecorticated)	-	£10.12.6	,,
Do. (decorticated, 50% oil and albuminoids)	-	£12.15	,,
Linseed	-	£13.15—£14	,,
Palm kernel	-	£7.10—£7.12.6	,,

Essential Oils.

Cajeput	-	3/- per lb.
Camphor (Chinese, crude)	-	2/7 ,,
Do. (Japanese, refined)	-	2/11 ,,

Essential Oils.—*contd.*

Camphor (oil)	- 60/-—65/- per cwt.
Cinnamon (Ceylon, leaf)	- 5½d.—6d. per oz.
Citronella (Ceylon)	- 3/3 per lb.
Do. (Java)	- 5/4 „
Clove	- 7/-—7/6 „
Lemon grass (Cochin)	- 3/6 „
Lime (West Indian, expressed)	- 9/- „
Do. (do. distilled)	- 5/3—5/6 „
Patchouli (Penang)	- 16/6 „
Do. (Mysore)	- 22/6 „
Vetiver (Bourbon)	- 30/- „

Spices.

Capsicums (East Indian)	- 40/-—45/- per cwt.
Do. (Nyassaland)	- 60/-—65/- „
Chillies (Zanzibar)	- 35/-—40/- „
Do. (Nyassaland)	- 50/-—60/- „
Do. (Japan)	- 119/- „
Cinnamon (Ceylon)	- 11d.—1/2 per lb.
Cloves (Zanzibar)	- 1/-—1/1 „
Do. (Penang)	- 2/6—3/- „
Ginger (Japan)	- 80/-—95/- per cwt.
Do. (Jamaica)	- 140/-—170/- „
Mace (Bombay and Penang)	- 2/1—3/- per lb.
Nutmegs (Singapore and Penang)—	
110's	- 2/- „
80's	- 2/4 „
64's—57's	- 2/5—2/6 „
Pepper (Singapore, black)	- 5d. „
Do. (do. white)	- 8d. „
Turmeric (Bengal)	- 80/- per cwt.

Drugs.

Cinchona Bark	- According to analysis.
Cocaine (hydrochloride)	- 16/3 per oz.
Ipecacuanha (Matto Grosso)	- 8/3—8/6 per lb.

Natural Dyestuffs and Extracts.

Annatto (seed)	- 1/1—1/2 per lb.
Gambier (block)	- 65/- per cwt.
Do. (cubes)	- 80/-—90/- „

Gums and Resins.

Damar (Singapore)	- 30/-—150/- per cwt.
Do. (Batavia)	- 120/-—160/- „
Dragon's blood (reeds)	- £18—£20 „
Do. (lump)	- £11—£28 „
Guttapercha (genuine)	- 2/9—6/- per lb.
Do. (Sarawak)	- 3/-—4/- „
Do. (Siak, reboiled)	- 10d. „
Jelutong	- £30—£60 per ton.

Fibres.

Cotton (American Ord. to F.G.M.)	-	15.39d.—17.39d. per lb.
Do. (Egyptian Sakellaridis, G.F. to fine)	-	24.50d.—27.35d. ,,
Hemp (Manila, "J" grade)	-	£42 per ton.
Do. (Mauritius)	-	£35—£46 ,,
Do. (New Zealand)	-	£35.10—£37.10 ,,
Do. (Sisal)	-	£21—£42.10 ,,
Kapok (Indian)	-	9d. per lb.
Do. (Java)	-	1/3 ,,

Foodstuffs.

Cocoa (Ceylon, plantation)	-	60/-—98/- per cwt (in bond)
Coffee (Malay, plantation)	-	100/-—130/- ,, ,,
Do. (Malay, Liberian)	-	78/-—83/- ,, ,,
Sago (pearl)	-	25/-—28/- ,,
Do. (flour)	-	17/6—18/6 ,,
Sugar (Java, white)	-	20/5 per cwt (excluding duty)
Tapioca (Penang, flake)	-	3¾d.—4d. per lb.
Do. (Penang, flour)	-	18/-—22/- per cwt.

Chemicals.

Acetic acid (glacial)	-	£69 per ton.
Do. (80% comml.)	-	£43 ,,
Acetone (pure)	-	£100 ,,
Ammonia (.880)	-	£22 ,,
Calcium acetate (grey)	-	£19—£20 ,,
Citric acid	-	1/5½—1/6 per lb.
Creosote	-	6d. per gallon.
Formalin (40% vol.)	-	£54 per ton.
Lime Juice (raw)	-	1/9—3/- per gallon.
Do. (concentrated)	-	£21—£22 per basis.*
Sodium bisulphite (60—62%)	-	£18—£19 per ton.
Sodium sulphite (anhydrous)	-	£27.10 - £28.10 ,,

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* Basis = 108 gallons, 61 ounces Citric Acid per gallon.

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SISAL HEMP.

By H. W. Jack, R. O. Bishop and J. N. Milsum.

THE purpose of this paper is to draw attention briefly, to the industrial possibilities of Sisal Hemp (*Agave sisalana*, Perrine.) in Malaya, since records compiled by the Department of Agriculture show that this crop can be grown successfully under local conditions and that the leaves contain a good average percentage of fibre of suitable length and quality. Moreover, as will be shown later, the present supply is insufficient to meet the existing demand for sisal, and there are indications that this demand will increase in the future.

Climate.

Sisal is by nature a tropical plant and its cultivation is most successful only where intense heat prevails during the greater part of the year, but the plant, being very hardy, has gradually become naturalised in most of the warm temperate regions of the globe and appears to thrive well within a belt extending thirty degrees north and south of the Equator.

Being physically adapted to withstand drought, sisal attains its optimum development in regions where a moderately long dry spell is customary, but the plant possesses a wonderful range of adaptability since it has been found to grow well under very humid conditions. Humid conditions accelerate the flowering period, but appear to have no material effect upon the quality of the fibre or upon the percentage of fibre obtainable from the leaves. Such conditions promote regular cropping.

The rainfall appears to be immaterial, provided that where it is low (25-40 inches) the soil is well cultivated and is capable of retaining a fair amount of moisture and that where the rainfall is high, drainage (preferably natural) is satisfactory as nothing retards the growth of the sisal plant so effectively as stagnant water either above or below the surface.

While the chief climatic requirement, assuming that the soil is suitable, is abundant sunshine, seasonal changes are advantageous in that a wet season greatly assists planting operations while dry weather

tends to reduce production costs, though the effect on the total output is unknown at present.

In Kenya, near the coast, sisal is reported to produce a higher percentage of fibre of a finer grade than that grown in the uplands, but inland a larger yield per acre is said to be obtained though in this regard opinions appear to differ and the evidence is inconclusive.

Habitat and Extension.

Sisal Hemp, so called from the name of the port in Yucatan from which it was first exported, is indigenous to tropical South America, Mexico and the Southern States of North America, but has gradually been introduced into most tropical countries and by cultivation has also become acclimatised in most warm temporate regions.

The plant is now well established in Florida, the West Indies, Africa (East, South and West), India Indo-China, the Dutch East Indies, the Philippines, Hawii, Papua, Fiji and the tropical parts of Australia, though commercial success in some of these countries still remains to be proved and depends largely on the abundance of cheap labour and transport conditions. Some closely allied species have even become naturalised on the hills of India up to an altitude of 6,000 feet where the atmosphere is not too moist and where sunshine is plentiful, and excellent crops of sisal are reported in Kenya at 5,000 feet.

The earliest efforts to introduce the fibre into commerce were made in Mexico in 1839, but it was found that the primitive methods of fibre extraction then employed were so tedious and costly even with the cheap labour of that time as to discourage increase of production. Some years later the offer of a prize led to the invention of a simple machine called the "raspador," and its employment gave the industry the required stimulus, so that it has expanded enormously, Mexico now being capable of producing 150,000 tons of fibre each year.

The industry promises well in East Africa and has already shown signs of rapid extension, the area under sisal in Kenya in 1922 being over 37,000 acres and in Taganyika 61,000 acres were planted in 1913 and the output was over 22,000 tons of fibre, and though the War rather set back the industry in this colony, it is again beginning to flourish. New machinery and cheaper transport tend to promote the commercial cultivation of sisal in other countries also, of which India, Sumatra, the Philippines and Queensland may be mentioned as probable centres of the commercial cultivation on a large scale. It is of local interest to note that in 1923 the Dutch East Indies exported 26,680 tons of sisal fibre of which 75% was shipped to America and the remainder to Holland and Germany.

Botanical.

Sisal Hemp is derived from the leaves of several species of Agave which belongs to the Natural Order—Amaryllidaceae—and much

confusion has arisen with regard to the nomenclature so that it is often difficult to establish the identity of plants yielding the commercial varieties of fibre. According to Professor Dewey there are three species which are concerned in the question of the commercial production of sisal:—(1) *Agave fourcroydes*, Lem., the Yucatan sisal plant which at present furnishes about eighty per cent of the world's supply and which is characterised by marginal spines on the leaves. This species was formerly known as *A, rigida var: elongata*, Baker. (2) *Agave sisalana*, Perrine., which is cultivated commercially in East Africa, India, West Indies, Indo-China and Sumatra. (3) *Agave cantala*, Roxb., which is grown in the Philippines, Java and India and produces a finer fibre than *A. sisalana.*

Agave sisalana, Perrine., is now regarded as the source of the standard sisal fibre and its cultivation is rapidly extending. This plant has a short stout trunk bearing a number of stiff and thick fleshy deep-green leaves which terminate in a tough spine. The leaves have smooth margins and a leathery epidermis and range in length up to six feet and in width from 4-6 inches according to age and soil conditions and are arranged in the form of a rosette. At a varying age, depending on climatic conditions, the plant flowers. The flowers are borne in dense clusters at the ends of short lateral branches which arise from the central flowering stem, the so-called "pole" which is some twenty to th rty feet in height. The "pole" at first bears numerous large bracts in the axils of which short lateral branches appear. After the flowers have commenced to wither, buds arise in the axils of the flower stalks. These buds produce small plants called "bulbils" which grow to a few inches in length and then fall to the ground and take root if the conditions are favourable.

The growing inflorescence and the production of bulbils deprive the leaves of their accumulated water and food, so that they become limp, and the plant withers and dies.

Sisal fibre consists of strands 3-5 feet long, nearly white or pale-yellowish in colour. The strands are strong and hard and are composed of a mass of ultimate fibres about 2 to 5 millimetres long which are polygonal in transverse section and have large polygonal lumena. The fibre substance consists of a lignified form of cellulose.

DISEASE.

Disease in sisal is practically unknown at present, and given tolerably suitable conditions, disease is not likely to be troublesome since the physical structure of the plant renders it naturally resistant to insect and fungoid pests. *Coniothyrium concentricum* is the only fungus disease so far reported as deterimental to the plant. There is a possibility that pig and deer may cause some trouble locally but no damage by these beasts has yet been reported. Scale insects are frequently found on the leaves in Tanganyika and a weevil (*Scyphorus acupunctatus*, Gyb.,) commonly attacks the "poles" just as they are dying, but neither can be regarded as an economic pest.

Introduction to Malaya.

Sisal was introduced into Malaya by the Agricultural Department in 1905, when a small area in Kuala Lumpur was planted at the same time as plots of Bowstring, Manila and Mauritius hemps.

The sisal then showed excellent growth and fibre samples displayed at the Agri-Horticultural Show in Penang in 1909 gained favourable comment.

The experimental block of plants at Kuala Lumpur flowered in 1911 producing sufficient bulbils to plant up several acres in Kuala Lumpur and a similar area at Gunong Angsi in 1912. In addition a fresh lot of material was imported from the Philippine Islands in 1913 and a few acres were planted at Batu Tiga and a small area in Kuala Lumpur.

Thus the present stock of material has been well acclimatised locally and of its hardy and satisfactory growth there is no doubt.

Soils.

It has been shown in East Africa and other sisal growing countries that a porous soil is essential for the successful cultivation of this crop. The root system of sisal is very active, and demands large quantities of oxygen from the air, which is only obtainable through the porosity of the soil. On flat land it is necessary to have efficient drainage as the roots are very impatient of water-logged soil. On undulating land, if effective provision is made against wash, good growth is made. Close silt-pitting appears to assist the growth of the plants by encouraging an extensive rooting system.

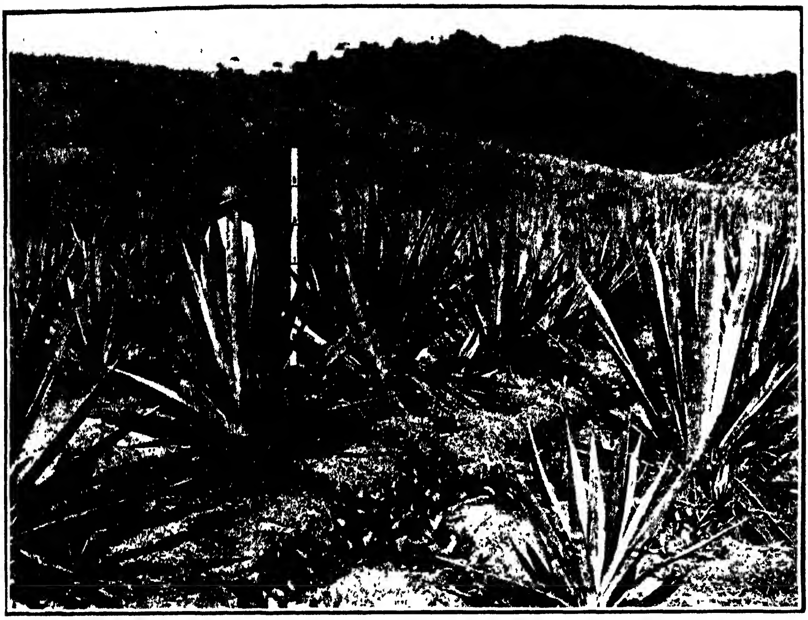
As far as growth is concerned, the average soils found on the western side of the Peninsula appear quite suitable for the requirements for this crop. The best growth is made in soils containing a relatively large proportion of coarse sand, *i.e.*, of a porous consistency. It is probable that excellent growth would be made in the rich chocolate loams obtaining in parts of central Pahang, where suitable areas of land are said to be available.

It is stated that of the mineral requirements of sisal, calcium is the most important and undoubtedly a fair amount of lime in the soil is beneficial to the growth of sisal. At the same time there appears no reason to suspect that plants grown in average land in this country suffer through insufficient lime.

Sisal Hemp will not grow successfully under shade and therefore must be ruled out as a catch crop under rubber.

Methods of Propagation and Nurseries.

There are two methods of propagating sisal, i.e., from bulbils and from suckers. Opinions differ as to which method is the better of the two, though in the case of new plantations, the former is the more economical. Experiments are in operation to test the relative advantages of both methods of propagation.



SISAL HEMP.
Two and a half years in the field.
Experimental Plantation, Serdang. Selangor.
September 1924.

SISAL HEMP SHOWING SUCKERING.
Two and a half years in the field.
Experimental Plantation, Serdang. Selangor.

Bulbils.—Nurseries should be laid out on good land not subject to wash. The beds should be about four feet wide interspaced with paths a foot wide. The surface soil from the paths should be lifted and placed on the beds, resulting in the land being raised, thus affording good drainage. The bulbils usually fall from the poles when they are about six inches long. They should be collected and planted directly in the nursery beds; exposure to the sun as in the case of suckers being unnecessary. Most of the bulbils will show roots and will make rapid headway in the loose soil of the nursery beds. The bulbils are spaced in the beds about one foot each way. No shading or watering is necessary in this climate. Little cultural attention is required beyond periodical weeding. The plants are ready for transplanting to the clearings within a year, when they will be from twelve to fifteen inches high.

The number of suckers produced from a plant pole is given as between 2,000 and 3,000 though from counts made at the Experimental Plantation, Kuala Lumpur, the average was found to be about 1,000. These plants had, however, been heavily pruned and were growing on poor soil that had suffered badly from wash.

Suckers.—On established plantations, suckers may be severed from the plants in the clearings and either grown on in nurseries or planted direct into the field. After collection, they should be placed in full sun for several days to enable the wounds to heal and thus to prevent the plants rotting. It is found necessary to allow suckers about three inches more space than bulbils in the nursery beds. Subsequent treatment is the same as that given to bulbils.

Clearing and Planting Methods.

Sisal is a crop that requires well-cleared land. In the case of virgin jungle, it is necessary to remove considerably more timber than is usual when planting rubber, for the planting distance of the crop is comparatively close and transport of the leaves to the factory is a matter of difficulty with much timber on the land. The ideal condition is clean-cleared land with all the stumps and roots removed, though it is doubtful whether this is possible on account of expense.

At the Experimental Plantation, Serdang, a planting distance of eight feet by eight feet square has been adopted, but this is considered too wide in Java, where five feet by five feet square is stated to be usual. Rows eight feet apart, the plants spaced five feet apart in the rows (giving 1,090 plants per acre) may be sufficient. The rows should run from east to west. Planting should be undertaken during rainy weather. After lining, holes about one foot deep and wide should be dug sometime prior to planting in order to allow the soil to become weathered. The young plants are best planted with the root crown flush with the surface of the soil which should be pressed down firmly.

It is not essential that the land be kept clean-weeded, provided lalang and blukar are kept down. The employment of creeping cover crops is not satisfactory on account of these plants climbing up the

sisal, necessitating constant supervision to prevent the crop becoming smothered. It might be practical to use bushy covers such as Tephrosia. On undulating land, a system of close silt-pitting is beneficial for the purpose of preventing wash and holding as much moisture in the soil as possible.

Harvesting.

The age at which the first cutting may be taken is variable but is usually after the third year. In Java, it is considered unwise to harvest too early on account of the relatively low percentage of fibre in young leaves. The leaves for cutting should be from four to five feet long but the lowest on the plant are frequently less. Maturity is indicated by the leaves bending to an angle of 45 degrees or less from the ground. Vertical leaves are not harvested. The leaf is cut close to the trunk, care being taken not to injure the younger leaves of the plant.

Harvesting is carried out on a definite system to allow of the crop being cut and treated in rotation. The time of harvesting is immaterial in this country, and in this respect sisal is a most accommodating crop as the leaves may be cut when convenient, though the most favourable period is during dry weather when the moisture content of the leaf is at its lowest.

Records of production in this country show that with three to four cuttings per annum an average annual yield of thirty leaves per plant may be obtained. At a planting distance of 8 feet by 5 feet, a yield of approximately 20 tons of green leaves are harvested per annum from mature plants, giving a return of dry fibre approaching one ton.

In Java, on poor land a yield of about 850 lbs. to 1,300 lbs. of dry fibre per acre per annum is obtained, whereas on good land as much as 2,650 lbs. may be secured.

The life of the sisal plant in this country has been found to vary from six to ten years. It is considered necessary, in Java, to replant a sisal clearing after ten years. This is done by replacing each plant which poles with a fresh plant, after the soil has been well changkolled. Land in this country may be insufficiently fertile for this to be possible, and in this case either some form of rotation would have to be instituted or steps taken to improve the soil by green manuring or allowing it to lie fallow for a time.

It is obvious that in dealing with a crop with such a high percentage of waste product as in the case of sisal, a very important item of expenditure will be transport of the raw material to the factory for treatment. The matter must receive attention when selecting the site for the factory, which should be situated in as central a position as possible. On large estates, the cheapest and most satisfactory form of transport is by means of a system of light railways. Permanent lines are laid to feed the factory, connecting with a system of moveable rails from the clearings in bearing. Monorails, as in use on certain oil palm estates, might be employed in the case of sisal cultivation.

In the factory, decortication of the leaves should be completed as soon as possible after cutting but in no case should decortication be delayed beyond three days, otherwise the fibre becomes permanently discoloured.

TREATMENT OF LEAVES—PREPARATION OF FIBRE.

The preparation of fibre from the leaves of sisal hemp is confined entirely to methods of decorticating the green leaf directly after cutting. Though the process of retting on the lines adopted for flax may be followed by certain native growers, it is established that the decortication of the green leaf can be carried out efficiently, and that the product is superior to that obtained when the leaves are retted first.

Any thought directed to the setting up of suitable machinery for the decortication of the leaves must be based on the fundamental consideration of expedition in handling the crop as it is harvested, and for that reason the factory must be situated centrally with an adequate and reliable water supply. The machinery should be so disposed that the green leaf can be decorticated and the fibre washed and passed to the drying racks within the shortest possible interval.

The essentials of the machinery required to prepare sisal fibre are quite simple, though modern practice and the search for greater efficiency has added improvements which increase the cost. The fibre can be roughly extracted from a sisal hemp leaf by passing the leaf a sufficient number of times through a pair of smooth rollers, such as those used for machining ordinary crepe rubber. The rolling serves to crush the leave cuticle and press the fibre away from its enveloping mass of vegetable tissue; hand washing is sufficient subsequently to prepare a good clean fibre.

In commercial practice, however it would be uneconomic to adopt any form of hand washing and consequently the machine which extracts the fibre must do so in such a manner that no vegetable tissue is left adhering to the fibre. The Raspador machine which was the first and for many years the only mechanical device constructed for this purpose is a rapidly revolving wheel carrying short vanes attached to the outside of its rim. The wheel is arranged to revolve so that the vanes just clear a heavy bed against which the leaf can be pressed and passed backwards and forwards through the intervening space. By this means the leaf is bruised and the fleshy matter scraped away from the fibre, the end of which remains in the hand of the operator.

A machine of this type capable of decorticating approximately one hundred leaves an hour is in use at the Department of Agriculture, and can be inspected by arrangement. It is used for preparing experimental parcels of sisal and other fibres, and cannot be regarded as efficient from an economic and industrial standpoint. The fibre treated by the Raspador requires further treatment to render it completely clean, and this cleansing is only possible by hand washing.

Modern improvements have been directed to the development of a machine which is capable of continuous feeding instead of the intermittent feed of the Raspador and a machine from which the fibre will be delivered throughly free from vegetable tissue. It appears from up-to-date literature that these objects have been achieved in a very great degree. The present sisal decorticator is capable of handling from 100,000 to 150,000 leaves per day, extracting from 2 to 2½ tons of fibre in eight or ten hours' time.

Thus each decorticator should turn out 400 to 500 tons of fibre in a year, and as this represents the leaves cut from, says, 400 to 500 acres, it follows that each area of about 1,500 acres of sisal should have one machine.

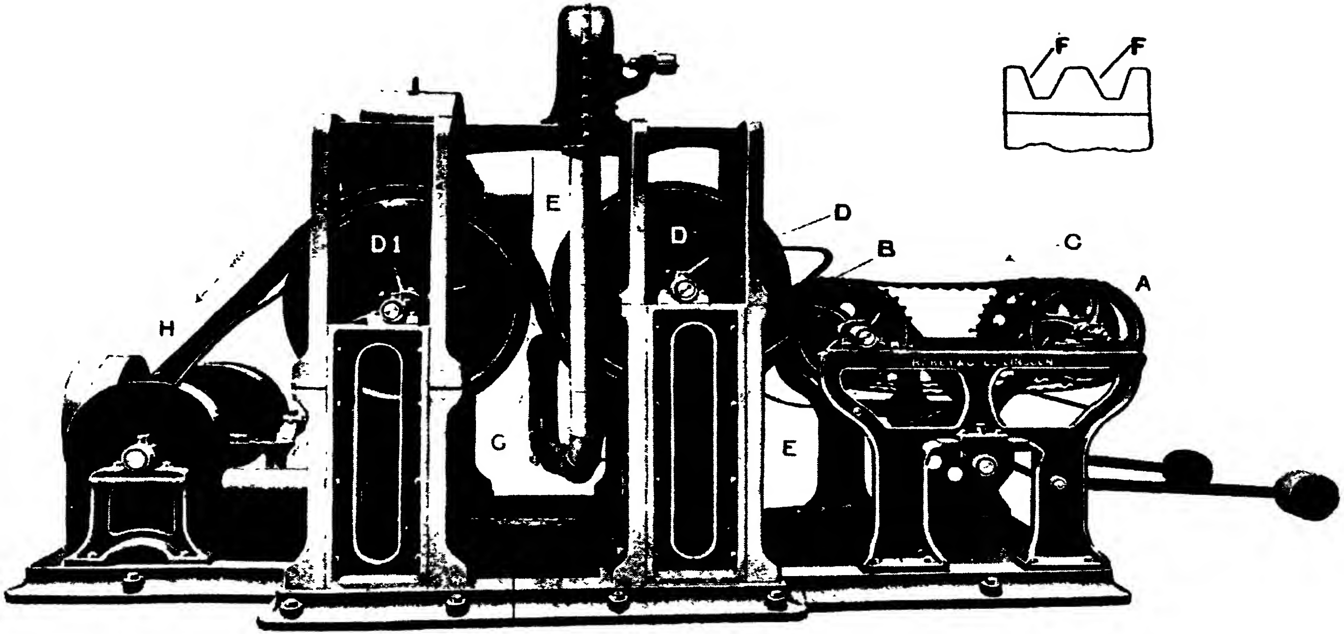
The decorticator which has proved most efficient in Yucatan and East Africa is Robey's patent improved machine which can be obtained from Robey Ltd. Lincoln, England,

In this machine (Plate I) the leaves are fed lengthwise on to the three link chains marked A, these working in the direction of the arrow. The leaf marked C, when reaching the point B, will be drawn down and caught between the feed drum D and the conveyor chain E, which goes underneath the feed drum D, the section of the feed drum being as shown on the side of the illustration, the conveyor chain working in the two grooves F. The end of the leaf opposite to that which is held in the feed drum, is drawn along, and the drum and concave, which are working at right-angles, strip off the whole of the pulp and leave only the clean fibre hanging down. When the clean fibre comes opposite the mouth of the blower G it will be blown forward, the other end still being held between the feed drum and the chain. The cleaned fibre is then caught between the conveyor chain E and the second feed drum Dl, the chain here passing over the top of the drum. The uncleaned portion of the leaf passes between the second drum and concave, and is duly cleaned, the completely cleaned fibre being delivered at a point H along the chain, a man standing there pulling it on one side.

The two drums are of cast-iron, perfectly balanced and true. The decortication knives, of an angular section, are bolted direct to the drum face and are adjustable by means of liners. The concaves are of phosphor bronze and made in two sections for easy renewal. A perforated copper pipe is arranged above each concave so as to spray water as directly as possible on to the leaves under treatment. A fan is bolted to the top of the machine and pipes are provided to direct the blast into the cleaned fibre coming from the first drum, so as to blow this between the underside of the chain and the second feed wheel. The capacity of Messrs. Robey's "Sixdecor" is 13,000 leaves per hour, or 2 to 2½ tons of fibre per day of eight to ten hours. A 60 b. h. p. engine should be provided to drive it. With a 16 ft. feed table it occupies a floor space 29 ft. 6 in. x 8 ft. 6 in., and weighs about 13 tons.

Where a small machine is required mention may be made of that produced by Lehmann of Manchester which is capable of treating 10,000 leaves daily and is driven by 2 b. h. p. engine.

PLATE I



The "Robey" Decorticator. Diagram illustrating method of working.

Yield of Fibre.

From leaves grown on the several Experimental Plantations, a number of trials have been conducted at the Department of Agriculture, Kuala Lumpur, using crushing rollers and a raspador machine to decorticate the leaves.

The results of this work are detailed below :—

Table I.

Percentage of Fibre in Sisal grown at Kuala Lumpur. Leaves harvested in November, 1921, from plants 6½ years old.

Direct decortication of green leaves.

Number of leaves.	Weight of leaves when cut.	Weight of dry fibre.	Percentage of dry fibre to green leaves.
	lbs.	ozs.	
11	12½	9¾	4.87
11	18	12½	4.34
10	14½	11½	4.96
11	13	8½	4.08
Decortication after retting in still water for 18 days.			
12	16	13.0	5.08
12	16½	12.0	4.54
12	15	9.75	4.06
12	15	10.0	4.27

Following on this preliminary trial, further extractions were carried out in 1924; for the purpose of comparison the leaves were harvested from the plants grown at the Experimental Plantation, Kuala Lumpur, and from other plants at the Experimental Plantation, Serdang, which had been planted in 1921.

TABLE II.

Plantation.	Age of plants. Years.	Date of harvesting.	Number of leaves.	Weight of leaves. lbs.	Weight of dried fibre. lbs.	Percentage dry fibre to green leaf.
K. Lumpur	8	25.7.24	100	147	7.5	5.1
Serdang	3	25.7.24	1,000	812	33.25	4.09
Serdang	3	17.9.24	991	1,274	42.75	3.35
Serdang	3	25.9.25	500	641	22.25	3.4
Serdang	3	4.10.24	400	457	15.75	3.45

These figures show that the sisal plants grown in this country at the two Plantations, yield a proportion of fibre which is comparable with the average yield obtained in the Philippines, Sumatra, Ceylon and East Africa. In Java, the yield of dry fibre, calculated on the wet leaf, varies from 3 to 5 per cent. Leaves from a three year old clearing are said to give 3 to 3½ per cent while leaves from a six to seven year old clearing give 4½ to 5 per cent of dry fibre. The high yield of 5 1 per cent of dry fibre from eight year old plants grown in Kuala Lumbur supports this statement although the sample on which the determination was made was considerably smaller than any of the other samples.

QUALITY OF FIBRE.

According to the standards of grading by the U.S.A.B. Bureau of Standards, the main points requiring consideration in fibre grading are as follows:— strength, colour, extent of cleaning, texture and finally length.

It would be of little value to make any definite statements about the general quality of the fibre produced by the Agricultural Department, or attempt to compare the quality with that of any particular grade of fibre now being offered in the world's markets, because our methods of production are experimental only.

It is however, of value to quote the results of tensile tests which have been carried out on the samples of fibre prepared in different ways and from different sources. The figures given in Tables III and IV for breaking strength are in our opinion indicative of the relative value of the fibre.

TABLE III.

	KUALA LUMPUR A.				KUALA LUMPUR B.				SERDANG A.				SERDANG B.			
Number of Samples.	Weight of Sample. Grms.	Breaking Load. Kgs.	Elongation at Break per cent.	Breaking Strength per unit gram length. Kgs.	Weight of Sample. Grms.	Breaking Load. Kgs.	Elongation at Break per cent.	Breaking Strength per unit gram length. Kgs.	Weight of Sample. Grms.	Breaking Load. Kgs.	Elongation at Break per cent.	Breaking Strength per unit gram length. Kgs.	Weight of Sample. Grms.	Breaking Load. Kgs.	Elongation at Break per cent.	Breaking Strength per unit gram length. Kgs.
1	.53	26.6	10%	50.1	.28	11.5	7.5%	41.0	.40	25.7	7.5%	64.2	.40	25 7	7.5%	64.2
2	.53	22.3	7.5%	42.0	.27	10.0	7.5%	37.0	.43	22.8	7.5%	53.0	.43	22.8	7.5%	53.0
3	.43	30.1	7.5%	70.0	.29	11.5	7.5%	39.6	.34	18.5	7.5%	54.4	34	18.5	7.5%	54.4
4	.51	24.8	7.5%	48.6	.29	13.3	5.0%	45.8	.35	18 3	7.5%	52 2	.35	18.3	7.5%	51.7
5	.51	32.0	10%	56.1	.39	14.3	5.0%	36.6	.43	22.3	7.5%	51.8	.43	22.3	7.5%	51.8
6	.61	26.5	7.5%	43.4	.27	18.7	7.5%	69.2	.38	19.4	7.5%	51.0	.38	19.4	7.5%	51.0
Breaking strength. Average 51.7					.............Average 44.8				..............Average 54.4				..............Average 54.3			

Description of Samples.

Kuala Lumpur A.—Leaves taken from an 8 year old plantation. Green leaf decorticated by machine and washed by hand.
Kuala Lumpur B.—Leaves taken from an 8 year old plantation. Green leaf retted for 14 days then decorticated by hand.
Serdang A.—Leaves taken from a 3 year old plantation. Green leaf decorticated by machine and washed by hand.
Serdang B.—Leaves taken from a 3 year old plantation. Green leaf stored 4 days before decortication and then treated as A.

For the purpose of the above tests "a sample" consisted of 20 strands of fibre cut to 50 cm. in length. Breaking tests were carried out on a Schopper Testing Machine. The length of fibre between the jaws of machine being fixed at 20 cms.

These figures show that the fibre obtained by the retting of leaves is inferior to that obtained by direct decortication of the green leaf. Secondly, the results show that the age of the plant does not cause any material difference in the strength of the ultimate fibre. From figures published by the Philippine Bureau of Science, it appears that the strength of the fibre produced in Malaya is quite as good as anything grown in the former country.

The results recorded in Table III indicate that the samples Serdang A and Serdang B are similar in tensile strength, but when compared as to colour and texture it is found that Serdang B is decidedly inferior. This inferiority is due to different treatment of the samples in preparation; Serdang A samples consisting of fibre which was extracted from freshly cut leaves, whereas in Serdang B samples the fibre was extracted from leaves which had been cut four days prior to decortication and in which decomposition had commenced as indicated by the blackening of the leaf.

In order to gain further information on the effect of delayed treatment of the leaves, that is, decortication of leaves cut and stored in air for one or two or three days, a batch of sisal from Serdang Plantation was cut and transported to Kuala Lumpur where it was divided into six separate bundles. These were decorticated on successive days and the fibre washed and dried in a uniform manner.

The yields obtained are recorded in Table IV. The leaves were cut on 17th September, 1924, from plants three years old. The average length of the leaves was 3 feet 8 inches, and the average breadth 4 inches. 1000 leaves weighed 1,336 lbs.

TABLE IV

Date treated	Number of leaves.	Weight of leaves. lbs.	Weight of fibre. lbs.	Per cent yield of fibre.
17th	100	123	4.125	3.3
18th	200	273	8.875	3.2
19th	100	135	4.75	3.0
20th	200	256	8.375	3.2
21st	200	243	8.25	3.0
23rd	191	244	8.375	3.4

The fibre from each day's decortications was treated in three different ways viz: —

(*a*) Removed from the rhaspador machine to washer. Washed 2 hours, then dried in the sun and brushed.

(*b*) Removed from rhaspador to washer. Washed 2 hours. Removed to fresh water, soaked 12 hours, then dried in sun and brushed.

(*c*) Removed from rhaspador to drying racks. Dried in sun and brushed. No washing.

The results of mean weight and relative breaking strength of the fibres from each day are given in Table V.

TABLE V.

Tensile tests of fibre prepared from leaves stored after cutting. Each sample consisted of 20 strands of fibre cut to 50 cms. in length, and each record is the mean of six determinations.

Time of storage of leaf before decortication.	Fibre washed 2 hours before drying.		Washed & soaked for 12 hours before drying		Unwashed, Dried and Brushed only.	
Days.	Mean Weight	Mean Strength	Mean Weight	Mean Strength	Mean. Weight	Mean Strength
	grms.	Kgs.	grms.	Kgs.	grms.	Kgs.
1st	0.37	55.4	0.30	60 0	0.42	54.7
2nd	0.36	48.8	0 37	59.0	0.38	56.0
3rd	0 38	58.3	0.38	62.1	0.41	52 6
4th	0 36	49.1	0 41	48.3	0.36	55 5
5th	0.32	58.0	0.42	56.4	0.35	59.0
6th	0.36	53.6	0.38	59.2	0.36	59.7

Breaking tests were carried out on a Schopper Testing Machine. The length of fibre between the jaws of the machine was fixed at 20 cms. when the load was applied.

A chemical examination of the fibres from the 1st, 3rd and 6th days gave the results recorded in Table VI. The fibres were washed after decortication for two hours and dried.

TABLE VI.

Chemical Examination of Sisal Hemp.

	1st Day Sample.	3rd Day Sample.	6th Day Sample.
Moisture	13.35%	11.72%	10.98%
The following are calculated on the moisture—free sample:—			
Ash.	0.94%	0.88%	0.90%
Water purification loss.	—	0.79%	—
Acid purification loss.	1.31%	0.93%	1.49%
Hydrolysis. A. loss.	12.05%	11.74%	11.11%
Hydrolysis. B. loss.	14.07%	13.74%	14.20%
Cellulose.	78.23%	77.08%	76.20%

From these figures it is evident that there is not any marked deterioration of the fibre owing to storage of the green leaf for two or three days after harvesting.

As long as the leaves themselves did not blacken there was no material depreciation in the colour and appearance of the fibre.

The result of the chemical examination, the losses on hydrolysis and the cellulose content of the fibre from the 1st day's sample indicate a high quality fibre comparable with the best produced in any other part of the world.

ECONOMICS.

The economics of sisal cultivation can be examined from various aspects. In the first place the individuality of the plant itself is worthy of consideration. As in all crop cultivation, variation in the degree of development of practically any character under observation is patent, though whether such variations are the expressions of inherent qualities or whether they are merely transitory fluctuations about a "mode" due to differences in physiological reaction to environment is not always easy to determine. However, the fact remains that genetic differences can be revealed by close examination. For instance it has been found that individual sisal plants of the same age grown side by side under apparently identical conditions show very large differences in the number and weight of leaves and in the weight of fibre produced per plant (6.)

Such material differences bear, of course, a most important relation to the successful economic cultivation of sisal and immediately arouse the prospective planter to the value of selection of stock for his plantation, since this factor directly affects the cost of production which is the vital question in the fibre industry. Fortunately, the existing stock in this country shows a high average standard as regards the percentage of fibre obtained from the leaves, though systematic selection, which is already being planned, will undeniably result in improved stock. Selection is rendered easy by the rapid natural vegetative means by which sisal is propagated, though of course, no results can be achieved without the lapse of at least one generation of plants.

Secondly, the crop as distinct from the individual plant requires much thought because the yield of fibre per acre is a factor that goes far in determining whether or not an estate is profitable.

The optimum number of plants which an acre can carry is still a problem in planting economics of which little is known, since sisal growing under cultivation as compared with the prevalent haphazard semi-wild methods existing in Central America is still a comparatively new industry. Experiments are being conducted at Serdang Plantation, Kuala Lumpur, with a view to solving this problem.

The object in view is, of course, to get the maximum crop off the land without unduly robbing the soil of its fertility, and as such,

is intimately connected with the problems of the preparation of land for planting and the treatment of the land during the period of the growth of a plantation and of succeeding crops.

The problem, put in a nutshell, is to determine the merits of replanting after a period of fallow or crop rotation as against replanting individual "holes" according as old plants die. Unfortunately, this is a problem which cannot yet be definitely answered as comparative date of yields derived by different methods are not available, for the simple reason that few areas systematically planted have yet reached the stage when the decision becomes necessary. In Kenya, the practice has been to clean the land thoroughly after the plants die and leave it to fallow for about a year or grow two bean crops before replanting. In Tanganyika, three successive crops have been taken from the land; the second and third plantings yielding poorer crops than the first. No doubt, either method of replanting is more economic than natural regeneration (for which the plant is well-adapted) on the grounds of access, transport and the health of the plantation. The problem of maintaining the fertility of the soil is one which the combined activities of the chemist and the agriculturist should solve, probably by the application of an efficient system of manuring coupled with routine cultivation.

Thirdly, due consideration must be given to the most economic size of a plantation, since the cost of machinery is prohibitive for dealing with too small an area.

In Yucatan, the estates vary in extent from 500 2,500 acres. In East Africa, an area of 7,200 acres and the installation of six extraction machines is recommended as the most economic unit (6) but estates of 300 - 400 acres earn a fair return (15—30%) on capital (3). Owing to the high cost of machinery, it is essential that the plantations should be fairly extensive in order that a large and regular supply of leaves may be available to the factory, which can only be efficient if it is kept working at or near its full capacity. Of course, much smaller areas can combine to produce the leaf necessary to maintain a common decorticator in full working; it might even be possible to establish a village industry on co-operative profit-sharing lines. The chief point is that the most economic machines must be supplied with enough leaf to keep them working regularly and at about full capacity.

The extraction machine shown in Plate I is capable of turning out 2 2½ tons of fibre daily or say 400 -500 tons per annum, allowing for stoppages; that is, it will mill the product of about 500 acres of mature plants annually. As the plants require some three years growth to bring the leaves to maturity, it is evident that this type of machine can only be run economically when an area of 1,000 —1,500 acres is available. For an area of this size the following planting programme might usefully be adopted. Divide the land into three sections, A, B & C, of approximately equal area. In the first year plant Section A, in the 4th year plant Section B, and plant Section C, in the 7th year. Thus, in the 4 year Section A would be in bearing. This section would be fallowed in the 8th-9th year and

Section B would be in bearing from 7th-11th years. Section B would be put in fallow in the 12th year and Section A would be replanted in the 10th-11th year when Section C would be in bearing. Thus, after the third yoar, one section would always be in bearing. Though the life of the plant averages locally 8 years, there would always be some leaf worth picking from each section in its ninth year which would add to the product of the next section in bearing so that the decorticator would always be receiving more leaf than that supplied by the actual section reckoned as in bearing.

In Tanganyika (3) in opening up 4,000 acres, it has been recommended that 200 acres should be planted annually and that each 200 acre block, when it has run its course, should be fallowed for several years according to special requirements. This question is very fully discussed by Major Notcutt (6) and the intending planter should study his views closely.

It is not intended that land should be left idle during its entire period of fallow. The land could be used, as in East Africa, to produce beans, or good crops locally might be found in ground-nuts for which there is a good European demand in addition to a thriving and profitable local market.

Fourthly, a survey must be made of local conditions. Under this heading the most vital points are transport facilities, labour supply, cheap and good water supply, soil and climate—economic factors which the experienced planter thoroughly appreciates.

Fifthly, a vital matter in the economic working of a sisal plantation is efficient supervision and management in order to make the best of local conditions, particularly with reference to labour organisation, which is probably the most material factor in cost of production, assuming other local conditions to be fairly favourable.

Supply, Demand and Prices.

The rapid development of modern manufacturing industries has disclosed the high degree of inter-dependence which to-day exists between different and widely separated industries. A few decades ago, it was apparently assumed that the world production of such an important staple as fibre would keep pace with the steadily advancing demand, but the enormously increased use of machinery which marks the progress of modern agriculture, particularly in respect of the cultivation of cereals, has revealed the fallacy of that assumption.

Not only has the consumption of wheat extended amongst white and coloured races of every nationality in the last twenty years, but the increased popularity of wheat as a staple diet is proved by an appreciable rise in the unit of consumption per head of population amongst peoples long accustomed to eat it. The demand for wheat and other cereal foods is steadily becoming more urgent—more land is being devoted to these crops and cheap labour is no longer abundant—hence, necessity has forced the invention and adoption of machinery to till the land and harvest the crop.

The utility of mechanical harvesters depends largely on the abundance of cheap and durable cordage material, and the existing demand for sisal fibre is chiefly due to the rapidly extending use of these machines coupled with the increasing difficulty of growing other suitable fibres. The present annual demand for binder twine in the Western States of America alone amounts to 200 million pounds. This source of demand absorbs almost the entire production of Central America (the principal home of the sisal plant) and the Bahamas, so that little fibre from these sources is available to supply the increasing demand in other countries.

The cultivation of sisal has been given attention in countries other than Central America during the last two decades, and the following table of production shows the extension that has taken place, though the figures cannot be taken as complete.

Production. (in tons.)

	1910	1911	1912	1913	1922
Mexico.	97,000	120,000	139,000	142,250	150,000
Tanganyika.	7,228	11,213	17,079	20,835	10,224
Kenya.	—	—	—	1,073	4,677
Java.	1,000	2,000	6,000	8,700	19,061
Bahamas.	3,000	3,600	3,000	8,236	1,156
Papua.	—	—	—	—	145
Philippines.	2,606	4,484	7,038	6,958	—

Unfortunately, the incidence of War retarded the expansion of the industry despite the fact that during war-time prices soared excessively as can be seen from a perusal of the following figures which give the average price per ton in Europe for each year. The prices are drawn from East African Reports down to 1917. The remaining prices are annual averages collected from reports from various countries, except where the month is mentioned.

Prices. (per Ton.)

1904	-	£36	1911	-	£25	1918	-	£45
1905	-	39	1912	-	30	1919	-	33
1906	-	40	1913	-	33	1920	-	35
1907	-	44	1914	-	29	1921	-	26
1908	-	31	1915	-	23	1922	-	28
1909	-	29	1916	-	32	1923	-	33
1910	-	28	1917	(June)	95	1924	(Aug.)	58

Prices fluctuate each month as may be guaged from the prices for March, June and August of this year which were quoted as £36, £47 and £58 respectively, but under normal industrial conditions

£30 per ton would appear to be a fairly safe figure on which to reckon. The average price for the last 21 years, (omitting the very abnormal war year —1917) was approximately £33 per ton.

Cost of Production.

The cost of cultivating sisal and preparing it for the market varies in different countries according to the local conditions already cited and the extent of operations, and as no data relative to the cost of production per ton of dry fibre in Malaya are as yet available from large scale plantations, inferences must be drawn from results published in other countries. In East Africa, where labour conditions are scarcely as favourable as in this country, the cost of production has been estimated at from £12 to £24 per ton including transport to the railway. Another East African estimate, which appeared in print in June of this year, fixed the return on capital at 25 per cent. basing the estimate on the moderate price of £30 per ton of fibre. The same estimate has been received from Java and the rapid extension of sisal cultivation in the Dutch East Indies, where conditions are very similar to those of Malaya, is significant of the profitable nature of the industry, whilst in Ceylon one estate has recently exported the fibre for the first time with highly satisfactory results. In the Gold Coast, with inexperienced and inefficient labour, the cost of production per ton, including depreciation (10 per cent), interest on capital (6 per cent), and a sinking fund for the repayment of capital (10 per cent.) on an area of 1,000 acres. has been calculated at £19.9.8. Major Notcutt (6) is convinced that costs can be reduced to around £14 per ton of fibre provided that planting is done on a sufficiently large scale and that local conditions are tolerably favourable.

Utilisaton of Sisal Refuse.

In the course of extracting the fibre from the leaf a large quantity of refuse is produced and a good deal of consideration has been devoted to determining the best way of utilising it. The refuse has been used as manure, being returned to the plantation either fresh or as ash after burning, and this practice no doubt helps materially in maintaining the fertility of the land.

The application of the ash to the land would, of course, be the less costly operation but the land will loose the organic nitrogen which the fresh refuse contains and only benefit to the extent of the mineral constituents of the ash, which is very rich in carbonate of lime and contains small quantities of potash and phosphate.

The possibility of utilising the refuse as a material for paper making has been suggested and was tried in Mexico and found to yield a very strong paper, but whether this use has been found profitable is not known to the writers.

It has also been suggested that leaf refuse could be used as a source of alcohol, but it seems doubtful whether the employment of the material for this purpose would be remunerative as considerable difficulty is found in fermenting it.

The waste contains a moderately high proportion of sugar and there is a possibility that it could be used in the dry form, mixed with other materials, as a feeding stuff for stock.

Fresh leaf was reported to have given fairly satisfactory results as cattle fodder.

In Germany, oxalic acid and wax have been prepared from sisal waste and the preparation has been patented.

Conclusion.

It has been shown that the sisal plant thrives exceedingly well in Malaya, that it is not subject to disease and that it produces fibre of good quality, readily saleable in London in large quantities. The increasing difficulty of growing hemp in Europe and the increasing use of binder twine for the machine reaping of cereals have been pointed out and indicate a long continuance of the existing healthy demand for sisal fibre.

In this paper results are given on the experimental work which has been carried out in the Department of Agriculture.

The writers are of opinion that this country is well suited to the commercial development of sisal plantations because of the facilities for the acquisition of suitable land, easy transport, adequate labour and efficient management.

These factors, coupled with the good average price which the fibre has realised during the past twenty years and more, emphasise the possibilities of the establishment of sisal as a sound and remunerative industry in Malaya. Furthermore, by the cultivation of sisal, returns on investment begin to accrue after a period which is fairly comparable to the rubber planting industry.

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1 Annual Report, Department of Agriculture, British East Africa, 1912-13.

2 Bulletin of the Imperial Institute, 1914, 1915, 1923, 1924.

3 Proceedings of the International Congress of Agriculture, 1914.

4 Philippine Agricultural Review, Vol. 16, No. 2, 1923.

5 British East Africa Agricultural Journal, 1909.

6 Sisal Economics—by Major Notcutt, Tropical Life, Vol. 19, Nos. 3 & 4, 1923.

DWARF COCONUTS.

By H. W. Jack.

RECENTLY, there have been so many enquiries regarding the economic aspects of the cultivation of the so-called dwarf coconut, that the following brief notes compiled from information which was kindly supplied from a few estates and from previous issues of the Malayan Agricultural Journal may be found useful.

In the Agricultural Bulletin, F.M.S., Vol. VII No. 3, 1919, the late Mr. W. P. Handover invited attention to the commercial possibilities of the cultivation of the dwarf coconut known locally as the "nyior gading" and showed that the variety must have been imported into Malaya from the Dutch East Indies.

He described the general growth and productive characters of the variety as exemplified by palms up to six years old grown on Sungei Nipah Estate, where 500 acres were planted in 1912 from seed-nuts obtained in the District of Krian, where the dwarf variety has been known to be under cultivation for some 30 years as a popular variety amongst the Banjarese rice planters.

The estimates published at that time were based on only two years of production and were described as conservative.

In the Malayan Agricultural Journal, Vol. X No. 1, 1922, Messrs. Jack and Sands described in detail the chief features of the fruits of the "dwarf" varieties and compared them with those of the "king" coconut of Ceylon and the "coco nino" of the Philippines from which they show decided differences. They pointed out that there were at least three distint types of the local "dwarf" or "nyior gading" variety, recognisable by the colour of their fruits and grouped as (*a*) apricot, (*b*) green, and (*c*) ivory yellow. On existing plantations these types are intermingled with each other and with ordinary talls and semi-talls though the ivory-yellow type predominates. This admixture of varieties is no doubt due, in part, to the fact that in planting these areas, a very large number of fruits had to be obtained from various sources, and it was not always possible to ascertain definitely whether each fruit had been obtained from a typical dwarf ivory-yellow palm. It is quite evident that natural crossing takes place between the tall and dwarf races, so that the semi-talls, or intermediate forms, which occur, are probably first generation hybrids between the talls and dwarfs. At the same time it has been shown that the percentage of seeds which breed true to the fruit colour is very high—as high as 96% in the case of the ivory-yellow variety. The talls may also be hybrids, but they are at present regarded as pure dominants which have segregated out in the 2nd generation of a cross between two races. Only careful breeding experiments can clear up many of the doubtful points connected with the inheritance of these quantitative and colour characters. The different colour types can readily be selected by the colours of the

young leaves of the germinating nuts in the nurseries, and this fact should assist planters very materially in planting out fields so that only the type desired is planted in each field. Not only can colour types be thus separated, but talls and semi-talls can be recognised by the growth characters of the young leaves fairly accurately.

The flowering characters of dwarfs are also described by Messrs: Jack and Sands and they show that, in the low-lands of Malaya where growth is so rapid, self-pollination is of very frequent occurrence.

As regards the commercial or yielding characters of the dwarfs as compared with the ordinary coconut, the following figures show the averages compiled from several estates under good average conditions.

	Ordinary.	Dwarf.
4th year—number of nuts per tree ...	0	15
5th " do. ...	5	30
6th " do. ...	20	55
7th " do. ..	30	75
8th " do. ...	40	90
10th " do. ...	55	100
Number of muts per pikul (133 lbs.) of copra ...	260	500
Yield of copra per acre in pikuls after 10 years	9	16
Cost of collection of nuts per 1,000	$1.20 cts.	.40 cts.
" husking " " "	.65 cts.	.50 cts.
Numbur of trees per acre	48	90
" " nuts " "	2,500	9,000
Thickness of meat	5/8 inch	½ inch
Average amount of meat per nut	510 grms.	165 grms.
" " " copra " "	240 grms.	125 grms
Average diameter of nut	5½ inch.	4⅓ inch.
" length "	5½ "	4¼ "

It is generally taken for granted that the life of dwarf trees is only about half that of the ordinary variety, though this supposition is only based on the statements of Banjarese and other cultivators.

Dwarf trees, still bearing quite well though over 30 years old, can be seen occasionally in different parts of the country, but there is no plantation of dwarfs old enough yet to guide opinions, though there seems no reason why they should not produce for at least 30 years under good estate cultivation.

It is, as yet, unknown which type of dwarf is the most productive of copra though the ivory-yellow type is the most popular possibly only because its bright colour attracts the eye more than the duller red and green types do. Theoretically, the green type should be the hardiest and strongest growing type because of the abundance of chloropyll contained in its leaf tissue, and the growth of young palms certainly bears out the theory in practice, though it still remains to be proved whether the green and apricot-red types can compare favourably with the ivory-yellow type from the view point of yield of nuts or copra per tree. The green fruits are usually bigger than those of the

ivory-yellow type. It has been suggested that dwarf palms are more susceptable to "spike moth" attack, but this may only be an environmental effect and in any case, the disease can be controlled.

Dwarf trees may also be used for the production of toddy, though it is said that the yield per flowering spike falls short by about one-third as compared with tall trees. At the same time, dwarf trees usually produce spikes in more rapid succession than tall trees and also they begin to produce spikes some 3-4 years earlier. Another consideration is that that the spikes of dwarf trees, in being situated much nearer the ground, are easier to tap, though the coolie has to tap more spikes to get the same amount of liquid as he gets from spikes of tall trees, and therefore prefers to deal with tall rather than dwarf trees. It is said that Tamils prefer toddy from dwarf to that from ordinary trees, the beverage being sweeter in the former case.

The information contained in this note is purely of a general nature, yet it is hoped that it will supply some of the information which is often requested by those interested in coconut cultivation.

Received for publication 10th April 1924.

INSECT PESTS OF LABUAN AND ADJACENT ISLANDS.

By B. A. R. Gater.

DURING the course of a visit to Labuan in connection with the Zygaenid pest of coconuts, *Artona catoxantha*, Hamps., several other insects of economic importance were noticed, and it is thought advisable to publish the details owing to there being very little information on record as to the economic fauna of this district. The information is not by any means complete, being the result of casual observations made during the odd moments of a week's work on the main object of the visit.

Crops in the past have been limited in number, but owing to the activity of Mr. W. W. Boyd other crops are being brought in and encouraged among the native cultivators. It is therefore of some importance that a little knowledge of the insect pests in the area should be forthcoming, especially since Labuan, although forming a part of the Straits Settlements has not had the advantage of a resident representative of the Agricultural Department.

Coconuts.

Artona catoxantha has twice appeared on the island of Pulo Kuraman, the second outbreak being of a more severe nature than the first. This pest has also appeared at Labuan and Rusukar Kechil at the same time as on Pulo Kuraman, and it is reasonable to presume that the moths spread to these districts from the centre of the attacks at Kuraman. The distances are from 1¼ to 2 miles, and in this respect it would appear that the moths have much greater powers of flight, aided probably by wind, than has beed noticed in the Federated Malay States. During the last attack the moths appeared at Kiamsam Point, Labuan, 2 miles from Pulo Kuraman, after the S. W. Monsoon had broken. They did not lay eggs, and as far as could be ascertained they had probably already completed oviposition before being driven over to the larger island. At Pulo Kuraman Sago palms were attacked, but Areca palms were untouched.

The absence of the large number of parasites usually associated with the later stages of outbreaks of this pest indicates that it may have been imported. When and how this occurred cannot be stated, but it does not appear that it came from Labuan. A careful search among the coconuts there neither revealed the presence of moths or cocoons nor any signs of the typical feeding marks made on the leaves by the caterpillars.

Parasites were few in number, not more than 5% of the caterpillars having been attacked. Evidences of the presence of the Clerid *Callimerus* sp., and cocoons of an Ichneumonid parasite, probably *Goryphus* sp., were seen. One caterpillar had been attacked by a polyembryonic Chalcidoid similar to one observed at Batu Gajah,

F.M.S., in 1923. The Tachinid parasites common in the F.M.S. could not be found, and 250 adults collected at Lenggong, F.M.S., were released.

A batch of 400 was originally collected, but owing to slight differences in the times of the life histories of the pest at Lenggong and Pulo Kuraman some were lost through emerging on the voyage. A total of 20% of the puparia collected was affected by various hyper-parasites, which is unusually high, and some care had to be taken not to release the hyperparasites with the parasites. Further details of the results of the investigations will be incorporated in another paper devoted to *Artona catoxantha.*

Apart from the above-mentioned pest the coconuts at Pulo Kuraman were remarkably clean. At Labuan, however, the damage done by the Rhinoceros Beetle (*Oryctes rhinoceros*, L.) is severe, no measures having been taken in the past to clear away old coconut stumps and logs, most of which contained the grubs of this insect. The Red Stripe Weevil (*Rhynchophorus schach*, Oliv.) was also present. The Lesser Spike Moth (*Batrachedra arenosella*, Walk.) could not be found. Other insects on coconuts were :—

Tirathaba sp. nr. *trichogramma*, Meyr (Pyralidae).
Amathusia phidippus, L.
Limacodid, prob: *Setora* sp.
Valanga nigricornis, Burm. (Acridiidae).
Aspidiotus destructor, Sign.

RICE.

Padi, both wet and hill varieties, was being planted out at the time, and the nursery plants appeared healthy. One nursery had been attacked by a caterpillar, which from the description given would appear to be *Spodoptera* sp. The following insects were seen :—

Cnaphalocrocis medinalis, Guen. (Pyralidae).
Nephotettix bipunctatus, F. (Jassidae).
Oxya sp. (Acridiidae)

Several other insects were seen in the padi nurseries, the Hesperiid, *Padraona gola* (?) Moore. being common. The sweet potatoe pest, *Cylas formicarius*, F. was present in the young padi, as were also the Carabid, *Casnoidea cyanocephala*, F., and *Alesia discolor*, F. (Coccinellidae).

HIBISCUS SPP.

Owing to the importance of insects affecting plants of this genus to cotton, roselle and other crops, the following list of insects found on Hibiscus is of considerable interest :—

Earias fabia, Stoll.
Dysdercus cingulatus, F.
Pseudococcus citri, Risso.
Saissetia nigra, Nietn.

In addition to the above two Pyrrhocorids and a Coreid were found which had not been recorded in our economic records. They were submitted to the Systematic Entomologist, F.M.S. Museums (H. M. Pendlebury) who considered No. 1623, to be *Odontopus* sp., No. 1624 *Dysdercus* sp. approaching *D. simplex*, Wlk., and No. 1651. *Serinetha* sp., possibly a local race or new.

Fruit.

Citrus trees appeared to be fairly healthy, few insects having been seen on them. *Papilio polytes*, L., *Aleurocanthus spiniferus*, Quaint. and *Pseudococcus citri*, Risso. were observed. Bananas were attacked to a small extent by *Erionota thrax*, L., while Psyllid galls were present in some numbers on *Eugenia malaccensis*. An unidentified Coccid was present on many specimens of *Artocarpus Kuntsleri*, giving rise to large quantities of "sooty mould." Mango was infested with Jassid nymphs, apparently *Idiocerus* sp. and it was reported that during the fruiting season a large number of fruits are affected by a beetle, which is probably *Cryptorhynchus mangiferae*, F.

Miscellaneous,

Adoretus compressus, Weber. (Rutelinae) and the Melolonthid, *Apogonia cribricollis*, Burm. appeared to be the most common night-feeding beetles, but were only noticeable in gardens, not having been complained of on field crops.

Locusts appeared in Labuan in 1919 and did some damage to the padi fields. Judging from a report by P. B. Richards, who visited the island at the time, the insect was identical with the one which was present in the F.M.S. in 1912—15, *i.e.*, *Locusta migratoria*, L. There was an outbreak of locusts in British North Borneo at the same time, and the swarms had evidently spread from there to Labuan. Communications are being established with scientists in B. N. Borneo with the object of studying points on the biology of this locust, many of which are obscure.

Received for publication 11th October, 1924.

THE RESOURCES OF THE EMPIRE:— RUBBER, TEA AND CACAO Etc.*

By W. A. MacLaren.

(*A Review.*)

IN a brief foreword H. R. H. the Prince of Wales opens this valuable book by likening it to a stock-taking of the natural products of the Empire, and thus emphasises its need in Empire economics.

In the "General Introduction" Sir Eric Geddes points out that there has been no standard work of reference giving the information required by business men throughout the Empire and that the aim of this book is to provide a compendious buyers' guide to our imperial resources. He shows that British imports from imperial sources have advanced considerably since 1923, and briefly summarises the area and population of the Empire pointing out the almost unlimited field for expansion of Empire trade along the lines of development of material resources. H. Eric Millar in an "Introductory Review" alludes to the important part played by the British race in the development of the World's natural resources and appeals to the present generation to honour the pioneers whose enterprise and daring opened so many doors in the past. He emphasises the importance of applying scientific research to tropical agriculture and the nature of the long risk to which planters of permanent crops are exposed, as compared with annual crops.

The Editor's foreword portrays the enormous scale of tropical agricultural production in the Empire and explains the imperial aspect of surplus production. The economic aspects are briefly touched upon and methods for conserving surplus production are suggested, while extension of British capital and enterprise to industries other than rubber and cacao, such as fibre, is hinted.

The pressing need for co ordinated colonial agricultural policy is stressed and a strong plea is made for more deliberate directive effort towards guiding the ignorant native producers in their choice of cultivations and getting them firmly settled on the land.

In early chapters the development of the rubber, tea and cacao industries are traced, and the histories of the slumps of 1920-21 are outlined together with explanations for their cause.

The methods of cultivation and preparation for the market of each crop are described; the organisations of the London markets are explained and some anomalies pointed out *e. g.*, purchase of rubber by appearance and not by quality.

The statistics of supply and consumption of each product in the world and in the Empire are given, and geographical surveys embracing statistics of acreage, acre yields, production prices and production

costs and average profits earned in each industry in each producing country within the Empire. Research organisations, disease control, local markets, labour and native methods are described in dealing with the principal industries. There is an interesting chapter describing little-known industries in products related to rubber—jelutong, guttapercha, balata and chicle—and the section dealing with spices is of interest in that it explains the cultivation, preparation for the market and trade in commodities with which few people are familiar. The book concludes with a useful chapter on tobacco which is treated with the same detail as to statistics and geographical survey as is portrayed in other crops. The book certainly fulfils its aim in forming a compendious buyers' guide and should prove interesting reading to all who have the advancement of the Empire at heart, whether they be planters, traders or professional men.—*H.W.J. 1-7-24*

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* Published by Ernest Benn & Co. Ltd., London 1924.

THE DETERMINATION OF THE BEST METHOD OF ESTIMATING POTATO YIELDS.

By R. N. Salaman.

Journal of Agricultural Science, Vol. XIII, Part 4, 1924.

THIS interesting paper, though based on work with the potato, is applicable to other annual crops.

It is commonly thought that the accuracy of yield determinations can only be reliable when they are based on large amounts taken from comparatively large blocks of land. This paper discloses the fallacy of this opinion and proves that, for the potato crop, a sufficient degree of accuracy (less than 5% of the crop) is obtained by using plots 1/160 of an acre in area, provided that not less than five duplications are used in the determination.

The experiments were carried out with plots of all sizes between 1/1635 and 1/21 of an acre, and with from 5 to 75 duplications.

The measure of accuracy employed throughout the experiment was the size of the probable error of the mean calculated by the method known as the "least squares" for different groups of plots arranged either end to end or side to side.

The paper also shows that long narrow plots are the most reliable for experimental purposes apart from the ease of working a narrow as opposed to a square plot. Moreover, a long plot is easier to supervise, (which is a material consideration,) much cheaper to work and in general, the shape of a plot is of far greater importance than its size.

In practice, the soils of most fields vary in some given direction and long narrow plots can be placed so that their long axis corresponds with the direction of soil variation, and thus the error from this factor is reduced to a minimum or even entirely excluded.

The results tabulated in the paper should prove of considerable value to workers dealing with annual crops locally.

H.W.J.

THE

Malayan Agricultural Journal.

Vol. XII December, 1924. No. 12.

EDITORIAL.

REORGANISATION.

Field Division.

In the February number of the current volume of this Journal the Secretary for Agriculture drew attention to the work of the Assistant Agricultural Inspectors and urged that greater use should be made of the services of these Officers by Planters and others. In accordance with the general policy of decentralisation, it has recently been decided further to extend the duties of the Inspection Staff; to make the change clearer, this Division will, in future, be known as the Field Division, and the present Chief Agriculural Inspector and Assistant Agricultural Inspectors as Chief Field Officer and Agricultural Field Officers respectively.

The duties of the enlarged Division will be responsibility under the Secretary for Agriculture for:

(1) Control of pests and diseases of plants. Advice to agriculturists regarding plant sanitation. Demonstration of control measures. Enforcement of Agricultural Pests legislation.

(2) Demonstrations relative to crop improvement. Distribution of selected planting material to native agriculturists. Maintenance of Experiment Stations.

(3) Co-operation with District Officers in organisation of District Agricultural Shows.

(4) Co-operation with the Education Department with regard to School Gardens. Provision of seed and planting material for School Gardens.

The Agricultural Field Officers will be responsible to the Residents of their respective States for the local performance of these duties. Their work will be supervised on behalf of the Secretary for Agriculture by the Chief Field Officer, who will also give advice calculated to ensure uniformity of policy and will disseminate useful information obtained in any one State.

In technical matters the Agricultural Field Officers will continue to have the advice and co-operation of the Headquarters Research Staff. In all other respects they will be agricultural authorities for their respective States and should invariably be the first to be consulted by the general public on all matters of local agriculture.

Economics Division.

Some of the duties of the Field Division as now defined were formerly carried out by the Instruction Division. The new duties of the latter Division will be :

(*a*) The economics and marketing of agricultural products, especially the produce of small holdings.

(*b*) Liaison with the Co-operative Societies Department. Encouragement of the co-operative movement among native agriculturists.

(*c*) Conferences of Malay Officers and Agricultural Shows, excluding organisation of District Shows. (assistance to be given to the latter on request, but no part would be taken in administration of District Shows).

(*d*) Publication of the Malay Bulletin and educative pamphlets in Malay on questions concerned with agricultural economics and marketing.

The new title will be "Economics Division." It is felt that this separation and definition of the duties of the Economic and Field Divisions will prevent any possible overlapping and make for greater efficiency.

Accompanying these changes, arrangements have been made to provide within the Department an adequate training for the growing staff of Malay Officers : a member of the former Instruction Division has been placed in entire charge of their training. This officer will retain the title of "Agricultural Instructor (Malay Officers)."

Agricultural Divisions.

From the beginning of next year the Department will be relieved of the task of supervising three of the Government Plantations—Sapintas, Kuala Tembeling and Pondok Tanjong. Advantage will be taken of this change to reorganise the Agricultural Divisions.

From the 1st January the present "Agriculturist" will become the "Agriculturist (Rubber)" and will devote his whole time to this crop; while the present Agriculturist, Government Plantations, will become the "Agriculturist" and will devote attention to crops other than rubber.

RECENT DEVELOPMENTS IN OIL PALM MACHINERY.

By B. J. Eaton.

THE problem of the most suitable type of machinery for the treatment of oil palm fruit, involving the separation of the pericarp from the fruit and the extraction of the palm oil from the pericarp has been under consideration for some years, especially by those interested in the cultivation of this crop on a plantation scale.

This problem is of importance from two points of view; firstly, the design of suitable plant for the native or for the small holder, and secondly, large scale factory plant for estate purposes. The latter point of view is at present of greater importance in Malaya, where the palm is being grown on a large scale, although a smaller type of plant suitable for the earlier stages of production on large estates is also of value.

The expression of oil, from the kernels need not concern the producer, since it is probable that the export of kernels will continue, the expression of the oil remaining in the hands of oil mills in the importing countries.

In an unpublished article written about two years ago, the writer discussed the possibility of extraction of palm oil from the pericarp by means of centrifugal machines instead of by hydraulic presses. It is of interest to note that this method is now an accomplished fact and, in the opinion of the writer, is a more efficient and economical process than that of hydraulic pressing.

Another interesting fact concerning this recent development is that the machinery has been designed by a British Company—Nigerian Products, Ltd.,—and constructed by one of the oldest oil expression machinery manufacturers in Great Britain—Messrs. Manlove Alliott and Co., Ltd., of Nottingham.

The writer has had the opportunity of seeing a complete plant of this type at work in the Nigerian Court of the West African Pavilion at the British Empire Exhibition, and has obtained from the makers an estimate of units capable of dealing respectively with 2 tons or 8-10 cwts of palm fruits per hour, which are included in this article. The makers also state that smaller units, even down to hand-power size, can be constructed.

Although it has not been possible to see in operation the plant designed by Culley Expressors, Ltd., and thus to make a comparison of the relative utility and efficiency of this plant with that constructed by Messrs. Manlove Alliott & Co., details of a Culley plant and an estimate of the cost as supplied by the makers are also given.

The essential difference between the two plants is that in the case of that by Manlove Alliott, no preliminary depericarping of the fruit is carried out, the whole fruit after a preliminary steaming in digestors being centrifuged for the extraction of oil. In the Culley process the fruit is first depericarped and the pericarp after steaming is centrifuged. In the absence of any comparative figures or a demonstration of a depericarper in operation the writer favours the Manlove Alliott process. In that process the pericarp is not removed from the nuts until after the palm oil has been separated in the centrifugal extractors. The separation of the pericarp is then a simple matter, especially if the residue of nut, with pericarp attached, has been passed through a suitable drier, preferably of the continuous rotary type.

Present Methods of Extraction.

Before dealing in detail with those latest processes for the extraction of the oil and separation of the kernels a brief description of the methods at present employed may be desirable.

The bunches of the fruit are removed from the palms by cutting with suitable knives and transported to collecting sheds. These sheds consist of long attap-roofed sheds, open at both ends. The bunches of fruit are placed on racks running the length of the sheds and composed of wooden or bamboo poles, with a sloping catchment shelf placed below. Many of the fruits ripen sufficiently to drop from the bunches within a few days. The fruits, which have not ripened sufficiently to drop from the bunches, are removed fairly easily by hand or by cutting close to the main stalks of the bunches. The detached fruits are then taken to the factory and treated as soon as possible, since it is well known that the oil from damaged fruit, or from fruit which is stored too long, deteriorates and contains a large percentage of free fatty acids, which reduces its value.

Mention might be made here of some experiments which have been carried out at the General Experiment Station A.V.R.O.S., Medan, Sumatra, employing a threshing machine for the mechanical separation of the fruits from the bunches. It has been suggested that, when working on a large scale, the method of first separating the fruits in the field, in addition to requiring the erection and maintenance of a large number of collecting sheds, may not be practicable.

In these experiments it was found that, although the separation of the fruits could be effected much more rapidly by threshing, the fruits were so bruised as to cause a considerable increase in the free fatty acid content. If, however, the bunches of fruit were sterilised by immersion in boiling water before passing through the threshing machine, it was found that there was no increase in the free fatty acid content of the resultant oil.

As compared with the method at present employed, the disadvantages are that approximately twice as much material (about half being waste) must be transported from the field to the factory and that larger heating vessels are required; the advantages are that no collecting sheds are necessary and that labour is reduced considerably.

In Malaya and the Dutch East Indies, the expression of the oil from the pericarp has been carried out hitherto in a somewhat primitive manner, using hand presses. The oil produced, however, has been of high quality containing, in the case of the Malayan product, less than 4 per cent. of free fatty acid (F.F.A.). In Sumatra, it is understood, estates have been satisfied with a F.F.A content of about 7 per cent.

Although, in the absence of suitable machinery, the methods of treatment of the fruit and expression have been described as primitive, this refers chiefly to the inefficiency of the process, whereby from 20 to 25 per cent. of oil remains in the pericarp and cannot be recovered except by efficient machinery.

The quality of the product—palm oil—is however, high, since the fruit is treated shortly after it reaches the factory and is subjected to heat by steaming, which prevents decomposition of the oil.

These primitive methods also require a considerable labour force in the factory, whereas the processes to be described are continuous and largely automatic.

Composition of Oil Palm Fruit.

The following table shows the average composition of oil palm fruit in Malaya :—

Pericarp 58 per cent.	...	Palm oil -	31 per cent.
		Fibre & Moisture	27 per cent.
Nut 42 per cent.	...	Shell -	35 per cent
		Kernel -	7 per cent

Yields.

The following figures showing approximate yields will enable an estimate to be made of the capacity of the plant required for dealing with the crop, assuming that the fruits are collected regularly during the whole year. It is probable, however, that during certain months the crop may be considerably higher than at other periods, and allowance will have to be made for this factor.

Individual palms may yield from 6 to 10 bunches of fruit per annum and the weight of the bunches may vary from 75 to 150 lbs. In the case of palms planted 55 per acre (30 ft. × 30 ft. triangular equilateral) a yield of 1,250 lbs. of palm oil and 330 lbs. of kernels per acre per annum is a conservative estimate in the sixth year after planting, increasing to 1 ton of palm oil and ¼ ton of kernels per acre per annum with palms in full bearing. Assuming a yield of palm oil of 1 ton per acre per annum, this will involve the treatment of approximately 3 tons of fruit per acre per annum.

An estate of 1,000 acres would thus produce 3,000 tons of fruit per annum or 10 tons per day on a basis of 300 working days per

annum, involving the treatment of about 1 ton of fruit per hour, assuming a 10 hour working day.

The writer is of the opinion, however, in view of the variations in yield during different seasons, that a plant capable of treating 2 tons of fruit per hour would be advisable for a 1,000 acre estate, although it is possible that such a plant will be found capable of dealing with the crop from a larger area.

Manlove Alliott Process.

The plant designed by Nigerian Products, Ltd., and constructed by Messrs. Manlove Alliott & Co., Ltd., is the result of experience gained in the mechanical treatment of the fruit in West Africa.

The original plant consisted of depericarpers and hydraulic presses with the necessary steam kettles for heating the fruit and pericarp. After a short period this type of plant was discarded and centrifugal machines installed for the separation of the palm oil from the whole fruit. This method has been found to give improved results, to be less costly and more efficient.

The process is as follows: The fruit is fed by means of a conveyor into a receiving hopper which feeds a vertical cylindrical digester. In the complete plant, details of which will be given later, two digesters and three centrifugal extractors, with an extra "basket," are employed, so that one extractor is available for filling or emptying, while the remaining two are in operation.

Each digester holds about 30 cwt. of fruit and is fitted with a vertical shaft and agitators. Steam about 3 lbs. above atmospheric pressure is introduced and the charge heated for 15 to 30 minutes. The heated fruit is discharged into a "creeper" feeding the centrifugal extractors.

Each extractor is fitted with a removable basket holding 5 cwt. of fruit and the charge is centrifuged for about 10 minutes. The palm oil is "thrown" through the perforated basket and discharged by a pipe in the outer casing of the centrifugal extractor into tanks placed on or below the surface of the ground. Steam is also injected into the centrifugals to assist the extraction of the oil.

The oil is then pumped into large settling tanks and, if necessary, heated by means of steam coils to allow the settlement of any coagulable or suspended matter. From the settling tanks the oil is discharged into storage tanks from which it is drawn off into barrels as required.

After the mass has been centrifuged the "basket" is lifted by means of chain blocks and carried by an overhead runway to a hopper feeding a rotary drier. This consists of a long cylindrical vessel, with the necessary baffle plates, mounted on a shaft slightly inclined

to the horizontal, so that the residual nuts and pericarp travel continuously from the higher to the lower end. This takes about 20 minutes by which time the nuts and pericarp are practically dry.

The baffle plates fixed on the sides of the cylinder lift the massed nuts and fibre and separate them, so that when the dried material is discharged the nuts are practically free from adhering fibre. The driver is rotated by an external cog-wheel and is heated internally by means of hot exhaust gases from a boiler.

The dried nuts and pericarp are then fed by means of an elevator on to a horizontal rotary screen mounted on a shaft in a tank or box, in which the separation is completed The fibre falls through the meshes of the screen and is used as fuel for the boilers, while the nuts are discharged into an elevator feeding two nut-cracking machines placed side by side. These machines are driven through a countershaft at about 1,000 revolutions per minute. After cracking, the shells and kernels fall direct on to a shaker screen, recovering any uncracked nuts, which are discharged into a separate bin to be returned to the nut crackers.

The kernels and the cracked shells fall through the meshes of the screen into a brine bath below. The density of the brine is such that the kernels float while the shells sink. (Note :—In Malaya and Sumatra, a bath of clay in suspension in water has hitherto been used for this purpose owing to the cost of salt, but with the recovery of the brine as practised in the process under review, the use of the brine bath appears to be more satisfacfory).

The bottom of the brine tank is fitted with a spiral conveyor which takes the shells to one end, where they are discharged into a receiving hopper, feeding a centrifuge in which the brine adhering to the shell is extracted and returned to the brine bath. The shells, which are almost dry, are then taken by means of an overhead runway to the boiler furnaces and used as fuel.

The kernels are skimmed from the surface of the brine bath by means of wire baskets and allowed to stand for a few minutes on a sloping tray to drain. They are then fed into another centrifuge, which separates the adhering brine. The kernels are then ready for immediate bagging for shipment.

The necessary steam for the whole plant, that is for the digester and the centrifugal extractors, can be raised by using the dried pericarp fibre and shells as fuel. The shells can, if necessary, be converted into charcoal, suitable for the manufacture of suction gas for the necessary power required.

The whole plant is designed with the object of saving labour and is practically automatic, for example only two operators are employed on the plant working at the British Empire Exhibition.

The following estimate and details have been supplied by Messrs. Manlove Aliott & Co :—

(Note :—The detailed descriptions of the various items have been omitted in order to save space ; only the names of the essential parts of the plant are given).

(a) *Capacity 2 tons of palm fruit per hour.*

The items are as follows :—

(1) Elevator for raising fruit to receiving bin for digesters.

(2) Mild steel fruit receiving bin.

(3) Two mild steel fruit digesters, 30 ins. diameter, capacity of each—1 ton of fruit per hour.

(4) Receiving hopper for delivering fruit from digesters to centrifugal extractors.

(5) Three centrifugal extractors.

(6) Two sets of lifting tackle to raise baskets from centrifugal extractors.

(7) Structural iron work for carrying digesters, countershaft and elevator.

(8) Runway with supporting columns.

(9) Two mild steel hoppers for receiving nuts and fibre from centrifugals.

(10) Spiral conveyor to convey nuts and fibre to elevator for rotary driver.

(11) Mild steel rotary driver with suction fan.

(12) Mild steel flue piping from boiler to drier, drier to fan, fan to atmosphere.

(13) Two elevators for raising nuts and fibre to separating screen.

(14) Nut and fibre separating screen with steel frame work and driving gear.

(15) Spiral conveyor from screen to elevator.

(16) Elevator to raise nuts to cracking machines.

(17) Two nut cracking machines with automatic worm feed.

(18) Shaker screen for separating uncracked nuts.

(19) Structural iron work for supporting nut crackers, screen and driving gear.

(20) Cast iron brine tank with shell conveyor.

(21) Kernel skimmers.

(22) Drip tray for receiving kernels.

(23) Shell conveyor with buckets, chains and driving gear to convey shells from brine bath to centrifuge.

(24) Mild steel shell bin for removing shells from elevator to centrifuge.

(25) Structural iron work for supporting shell bin.

(26) Two centrifuges for drying shells and kernels.

(27) Two runways with supports, and two sets of lifting tackle to lift baskets from centrifuges.

Total price of the above plant £1,321 0 0, plus 6 per cent. for packing for shipment and delivery f.o.b. English port.

The whole of the necessary mild steel shafting for driving the above machinery, including main and countershafts, necessary support frames and pulleys (except pulley receiving power from engine, and belting) £273 0 0, plus 6 per cent. for packing for shipment and delivery f.o.b. English port.

The following steam power plant for driving is recommended: —

(1) Two horizontal multitubular circular fire box boilers (Robey & Co.,) working pressure of 80 lbs. per square inch and capacity of 2,500 lbs. of steam per hour, using wood fuel or shell or fibre refuse, fitted with donkey pump and injector for alternative feeding. Price £1,060.0.0, packed for shipment and delivered f.o.b. Liverpool.

(2) Improved double cylinder medium stroke horizontal steam engine (Robey & Co.). Price £189.10.0, packed for shipment and delivered f.o.b. Liverpool.

The following are the details of the storage tanks for the palm oil:—

(1) Tank for receiving palm oil from the centrifugal extractors, 5 ft. × 5 ft. × 3 ft. Price £35.0.0.

(2) Oil storage tank of 25 tons capacity, 21 ft. × 8 ft. × 6 ft., with three compartments. Price £87.10.0, per tank.

The tanks are constructed at the works and then taken down for shipment.

(b) *Capacity 8 to 10 cwts. of palm fruit per hour.*

The smaller plant for treating 8 to 10 cwts. per hour consists of the following items :—

(1) Elevator for raising fruit to receiving bin for digester.

(2) Receiving bin.

(3) Digester.

(4) Centrifugal extractor (40 ins. diameter).

(5) Double steam jacketed spiral conveyor drier for nuts and fibre from centrifugal extractor, working in conjunction with exhaust fan for exhausting vapours.

(6) Elevator for raising nuts and fibre to separating screen.

(7) Driving gear for conveyor drier.

(8) Hexagonal rotary separating screen for separating nuts and fibre.

(9) Elevator for raising nuts to receiving bin over nut crackers.

(10) Receiving bin with necessary supports.

(11) Two nut cracking machines mounted on frame, supporting revolving screen for separation of uncracked nuts.

(12) Brine tank.

Total price of the above plant £1,610.0.0, plus 6 per cent. for packing for shipment and delivery f.o.b. English port.

The makers state that for the above plant it will be necessary to provide about 35 B.H.P. for driving, and an extra 300 lbs. of steam per hour for use with the digester and conveyor drier.

A rotary drier, similar to that described for the larger plant, in order to utilise the exhaust gases from the boiler for drying the nuts and pericarp refuse can be supplied at an extra cost of £50.0.0.

From observation of the plant in the Nigerian Court of the West African Pavilion at the British Empire Exhibition the writer can confirm the maker's statement that the initial cost of the plant is low,

operating expenses are cheap, and further the plant can be worked without skilled labour.

Culley Process.

As far as the writer is aware, the only other firm exhibiting oil palm machinery at the British Empire Exhibition is Culley Expressors Ltd. Unfortunately their machinery is not in operation so that the efficiency of the plant, especially in regard to the depericarping machine, which is such an essential feature of this process, cannot be judged.

Assuming that the depericarping of the fruit before extraction of the palm oil is necessary, a satisfactory method of carrying out this separation mechanically has hitherto presented many difficulties, as is evident from the number of machines designed and patented for this purpose from time to time. It is claimed that the Culley depericarper has solved the problem satisfactorily.

The following is a brief description of the process.—The fresh ripe fruit is fed into a steriliser, which consists essentially of a steam jacketed kettle, but no steam or water comes in contact with the fruit and no agitators are used in the kettle. The fruit takes about half an hour to pass through the kettle, and is thus heated thoroughly before being fed into the depericarper. This machine removes the pericarp from the nuts in a continuous operation without the use of screens or water, and discharges the clean nuts into a chute from which they are taken away for storage and drying, so that the kernels can shrink before the nuts are cracked.

The pericarp is collected on a travelling band, which delivers into a receiving tank fitted with two strainers on a movable frame, so that when one of the strainers is full, the other may be moved into position. The contents of the strainer are discharged into a steam driven centrifugal extractor, fitted with a perforated metal basket. Exhaust steam is used for heating the basket so as to facilitate the flow of oil.

The oil from the extractor is collected in settling tanks, fitted with closed steam coils, in order to heat the oil, so as to coagulate mucilage and other suspended matter, which settle to the bottom. The oil is then passed through a filter press into storage tanks from which it is run into barrels for shipment.

(Note :—Although no filter presses are included in the Manlove Alliott process, it may be found preferable in that case also to filter the oil before shipment).

A hand operated machine capable of treating at least 2 cwt. of fruit per hour is also made by this firm for small holders. In this case the separated pericarp is reheated and pressed in a hand-operated screw-press or the oil may be separated by treating the heated pulp in a small steam-driven centrifugal extractor.

The following estimate and details have been supplied by Culley Expressors Ltd. :—

(a) *Capacity 10 cwt. of palm fruit per hour.*

The items are as follows :—

(1) Sterilising kettle, steam jacketed.

(2) Set of elevators for lifting fruit from kettle to depericarping machine.

(3) Culley's patent depericarping machine.

(4) Drip tray for depericarper.

(5) Fibre and oil collecting tank.

(6) Travelling pulley block for lifting weights up to 5 cwt.. (Runway joist not included).

(7) No. 4 patent steam driven turbine centrifugal oil extractor, fitted with two removable perforated steel baskets.

(8) Swing crane for lifting baskets from centrifugal extractor.

(9) Steel channel for conveying oil from centrifugal extractor to receiving trough.

(10) Receiving trough.

(11) Settling tank, capacity 10 tons, divided into two compartments and fitted with steam coils.

(12) Double set of pumps (with supporting bracket) for pumping palm oil from receiving trough and fibre and collecting tank.

(13) Filter press, capable of dealing with oil from 1 ton of fruit per hour.

(14) Steel channel for conveying oil from filter press to storage tank.

(15) Storage tank, capacity 10 tons of oil, fitted with steam coils.

(16) Necessary piping for steam heating and conveying oil.

(17) Four tipping bogies, capacity 4.8 cubic feet. Two for removing the cleaned nuts from the depericarper and two for removing the pericarp from the centrifugal extractor.

(18) Requisite nut-cracking machines and plant for separatink kernels from shells.

Total price of the above plant £2,500.0.0., packed for shipment and delivered f.o.b. English port.

(b) *Small hand-operated plant.*

(1) Culley patent hand-operated depericarping machine. Price £45.0,0.

(2) Culley-Ducolson hand screw press. Price £14.0.0.

(3) Patent turbine centrifugal oil extractor, steam driven. Price £93.5.0. The centrifugal extractor requires from 70 to 96 pounds of steam per hour, according to steam pressure available, but under 3 H. P. boiler rating. No shafting or belting is required.

The centrifugal extractor is recommended as giving much more efficient results than the hand screw press.

Remarks and Conclusions.

The writer is convinced from his observation of the plant at the British Empire Exhibition that the problem of a simple, efficient and economical process for the extraction of palm oil has been solved satisfactorily.

The essential differences between the processes of Messrs. Manlove Alliott & Co., and Culley Expressors, Ltd., are that in the former process the whole fruit is treated direct in the centrifugal extractors after digestion with live steam at low pressure, whereas in the Culley process the pericarp is first separated in a special depericarping machine, after the fruit has been heated in a digester with no direct contact of steam.

It is stated that direct contact with live steam is liable to decompose the oil into free fatty acid and glycerine, thus yielding a somewhat inferior oil with consequent loss of glycerine in the water from the condensed steam. From actual experience with the treatment of palm fruits with either boiling water or low pressure steam, the writer is of the opinion that this factor is of little or no significance.

The treatment of pericarp alone in the centrifugal extractors, as in the Culley process, will mean a larger output from those machines, since the nuts are not introduced, but it must be remembered that an extra operation, namely depericarping, involing the use of a special machine, is thereby included.

As stated before, no definite decision can be laid down as to the respective merits of the two processes in the absence of a direct comparison of the two machines in operation. It can be stated, however, that the plant constructed by Messrs. Manlove Alliott & Co., carries out the various operations efficiently and automatically, is simple in operation and appears to be economical, and it is of interest to note that Tennamaram Estate, the largest palm oil producing estate in Malaya at present, has already ordered one of these plants.

It is to be hoped that the solution of this problem will give a renewed impetus to the cultivation of the crop in this country.

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FODDER AND GRAZING GRASSES IN MALAYA.

BY J. N. MILSUM.

TO those who appreciate the value of a well maintained pasture, it is a matter of wonder that this important aspect of agriculture is so neglected in the Malay Peninsula. Where grass is required as fodder for cattle at the present time, it is the general rule to have the supplies collected daily from swampy land in the neighbourhood. The kind of grass cut varies according to the district, situation, and person employed in collecting the fodder. Whereas some grass-cutters will take almost any low vegetation sufficiently long to cut, others will show a certain amount of discrimination and collect those grasses, which are succulent and preferred by cattle. In open swamps the best species is *Leersia hexandra*, a tall, slender marsh grass with narrow leaves. This grass frequently occupies large areas and is widely distributed throughout the Peninsula. It is relished by cattle, and is one of the best native fodder grasses.

In the general absence of enclosed pastures in this country, it is a matter of considerable difficulty to effect improvements to the turf on a basis that is economically sound. The system of growing paddy as practised by Malays on the river banks in Pahang, known as tenggala cultivation, is a native method of utilizing a three to four-year fallow for the production of fodder for buffaloes and other cattle that are employed in the cultivation of paddy. The predominating species occurring on such land is the Love grass, *Chrysopogon aciculatus*. This practice is generally well known and requires little further mention as being only applicable to types of land that are comparatively flat with a high water-table. On dryer areas, unless special attention be given to the land, the soil becomes invaded with lalang (*Imperata arundinacea*) to such an extent that the more desirable grasses have little chance of becoming established. The best existing pastures are those sometimes met with as reclaimed swamps on estates; the land here has been cleared of all tall growth and drained, resulting in a thick mat of broad-leaved grasses, which is usually composed of the following species.—*Paspalum platycaule*, *P. conjugatum*, *Isachne australis*, and *Panicum indicum*, with a number of low sedges such as species of *Kyllingas*, *Scleria* and *Fimbristylis*. These grasses provide a pasture very suitable for grazing cattle, being low, dense and succulent. Such land is, however, not always available and it is evident that the dryer types of land must receive some consideration from a number of standpoints. It is desirable, therefore, that investigations be directed to ascertain what grasses will thrive on the ordinary land of the country and what methods should be adopted to maintain the desirable species in a permanent state.

On dry open land, observations tend to show that *Zoysia pungens*, a small tufted, glabrous, much branched grass, occurring generally throughout the country, is a valuable grazing grass. In some districts this grass is very common, especially in sandy spots near the sea, often forming a dense turf. Cattle graze it readily.

The question of temporary pastures is one that can be but briefly touched at present as though there are a number of suitable fodder plants, the expense incurred in their cultivation is frequently such as to prohibit their general acceptance, more especially by natives. There are, however, several fodder grasses that produce a high return for a moderate amount of cultivation and it appears quite possible that should these be grown in rotation with suitable leguminous crops, a valuable fodder might be obtained with profit. Several such grasses have proved satisfactory under cultivation at the Experimental Plantation, Serdang, Selangor.

The subject of fodder and grazing grasses may be classified conveniently under two headings:-

(*a*) Stall Feeding.

(*b*) Pasture Land.

The following grasses have shown themselves satisfactory under trial:—

Stall Feeding.

Guinea Grasss, *Panicum maximum.*

Mauritius Grass, *Panicum muticum.*

Napier Grass, *Pennisetum purpureum.*

Pasture Land.

Dallis Grass, *Paspalum dilatatum.*

Carpet Grass, *Axonopus compressus.*

Stall Feeding.

Undoubtedly the most satisfactory grass for this purpose is Guinea Grass. This grass has been referred to as the best forage grass in the world and results to date prove conclusively its value in the Malay Peninsula.

Guinea Grass, *Panicum Maximum.*

A large perennial grass, forming a great number of suckers and thereby growing into large stools. Height 4 to 7 feet. A native of tropical Africa, it is now commonly grown throughout the tropics as a fodder grass. At the Experimental Plantation, Serdang, cattle have been fed continuously on this grass as a sole fodder with excellent results. In Sumatra, where the Deli Pony is employed in the towns, there is a considerable demand for this fodder. This is met by the cultivation of small plots of Guinea Grass in the majority of native holdings in the vicinity of the towns. Guinea Grass is largely

cultivated in Hong Kong for the purpose of providing fodder for dairy cattle. It is also used extensively in the West Indies, Java and the Philippine Islands.

Palatableness is the first consideration with forage plants and Guinea Grass is eaten greedily by cattle, horses and goats. Trials instituted by the Department of Agriculture, Ceylon at the Experimental Station, Peradeniya in 1922, to ascertain the relative palatableness of a number of grasses under trial there, showed this grass to be easily first in favour with cattle.*

Soils.—This grass adapts itself to a wide range of soils, but prefers a sandy well-drained soil, which is fairly moist. Ravines and other damp places in the estate may be utilized for the cultivation of this fodder, provided the water-table is sufficiently low. On dry exposed land the quantity of fodder decreases and the grass is less palatable to cattle on account of the stiffness of its growth and higher fibre content.

Preparation of the Land.—The area to be planted should be situated as near as possible to the place where the forage is to be fed to facilitate transport. The land should be clean cleared and well cultivated to a depth of ten inches. If the land be subject to heavy wash, steps should be taken by silt pitting or other means to prevent rain water from damaging the surface soil and washing out the newly-planted divisions.

Propagation.—The grass may be propagated either from seed or from divisions. The latter is the more satisfactory method, but, when a commencement is to be made to establish this grass, the former method may be adopted. Seed is not, however, produced in much abundance and is generally difficult to obtain. Fresh seeds germinate readily, and should be sown thinly in prepared beds and subsequently transplanted to the field. The seedlings are ready for transplanting in three weeks from germination and receive no check if planted out during showery weather. The first crop of fodder may be cut within three months from transplanting.

Divisions may be planted any time except in very dry weather. The best results are obtained when the beds are laid out at the commencement of the rains. In planting it is important that the soil be pressed firmly around each plant. The first cutting may be made in three to four months time.

The planting distance recommended for both seedlings and divisions is three feet by three feet square. When planted on poor land or in a dry situation, the distance may be reduced six inches either way.

Little cultural attention is required after planting beyond an occasional stirring of the surface soil to keep down weeds, and during dry weather to prevent undue evaporation. The loose earth may be slightly mounded around the stools.

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* Trop: Agriculturist. Ceylon. Vol: LIX. No. 4. p.216.

Production.—A yield of about 7,000 lbs. of green fodder may be cut from an acre every four weeks or approximately forty tons per acre per annum. A heavier yield per cutting is obtained during the rains, but this is an average figure for the year, At the Experimental Plantation, Serdang. an area of half an acre of land is found sufficient to produce enough fodder to feed two pairs of bullocks, allowing each animal the grass from one chain of stools, i.e., twenty-two plants per day. The area measures five chains by a chain and by cutting four rows per day the grass is grown sufficiently to recommence cutting again when the plot has been worked through.

An average daily ration is found to be about 50 lbs. of fresh grass in addition to the usual ration of cereal food. The latter for working bullocks consists of a pound of broken rice and 5¼ lbs. of bran with a dash of salt and a little coconut oil. When commencing to feed animals on this grass, care should be taken to mix it with ordinary grasses in the first instance so as to enable the cattle to become accustomed to it by degrees. If fed as a sole fodder ration suddenly, it is occasionally liable to act as a laxative.

Manuring.—After the fourth cutting, an application of twenty cartloads of well-rotted cattle manure per acre should be placed between the rows of grass and lightly changkolled in. To maintain heavy yields of fodder, this operation should be repeated every six months. The amount of fodder being continuously removed from the land is so large that frequent heavy dressings of manure are necessary.

Replanting.—When a plot has been under this grass for a time, a deterioration in production and quality is noted. The stools become large and burdened with a quantity of old growth. This may occur within two to three years according to the condition of the land. When this occurs, the stools should be lifted and divided, and the land thoroughly cultivated and replanted with divisions. When practicable, it is advisable to seek fresh land and crop the old area with ground nuts or some other leguminous plant.

The following analyses of Guinea Grass were made at the Bureau of Science, Manila* and the Department of Agriculture, Ceylon†.

	Philippine Isles. per cent.	Ceylon. per cent.
Water	... 77.85	77.26
Ash	... 2.85	3.30
Proteids	... 3.34	3.47
Carbohydrates	... 8.09	8.90
Fat	... .57	.55
Woody Fibre	... 7.30	6.53

* Philippine Agricultural Review, Vol: VII, No. 5, p. 211.

† Tropical Agriculturist, l.c.

Mauritius Grass, *PANICUM MUTICUM.*

A strong, creeping, perennial grass, of rapid growth, producing a large amount of palatable fodder. It attains a height of about 6 feet. This grass is now widely grown in the tropics and is stated to be found in a wild state in South America. In Ceylon it is well known as a fodder, but is rarely met with in this country. It thrives in moister conditions than does Guinea Grass.

This grass grows well at the Experimental Plantation, Serdang, and has also been grown with considerable success by the Assistant Agricultural Inspector, Perak South, on a small plot of state land at Kampar, Perak. This officer has supplied some notes on the behaviour of Mauritius Grass as a fodder in that State, and these have been incorporated here.

Soil.—This grass is a heavy feeder and requires plenty of moisture. On dry sandy soil, coarse growth is made and the plants eventually die out. The land should be prepared as in the case of Guinea grass with plenty of well-rotted manure incorporated in the soil.

Propagation.—This grass is increased by division of the runners. These root readily if cut into pieces of two or three joints each and pushed into freshly cultivated land, so as to leave the upper joint at about the surface of the soil. The divisions may be planted fairly closely, i.e., 1 to 2 feet apart according to situation. It is necessary to keep the land clean for the first two months after planting, when its growth becomes sufficiently dense to keep down weeds.

Production.—The first cutting may be made in two to three months from planting, when the plants are just throwing up their flower spikes. Subsequent cuttings may be made every two months or so, except in dry weather when growth becomes closer. A yield of about 35 tons of green fodder per annum is obtained from an acre. Each cutting, except during dry weather, yielding at least 5 tons of palatable fodder. Considerably higher yields are reported to have been obtained at Kampar, Perak.

Cultivation.—The land should be cleared and replanted every 2—3 years as in the case of Guinea Grass, and, where possible, a fresh area should be taken under cultivation and the old area be given a change of cropping. Heavy manuring is necessary to maintain high returns of fodder.

The analysis below is given by the Department of Agriculture, Ceylon, in the paper already referred to.

		Per cent.
Moisture	...	76.80
Ash	...	3.00
Proteids	...	1.40
Carbohydrates	...	12.20
Nitrogen	...	.23
Woody Fibre	...	6.80

Napier Grass, *PENNISETUM PURPUREUM*

A tall perennial grass, native of tropical Africa, growing in clumps, and attaining a height of 18 feet. It was first cultivated in Rhodesia in 1909, and from there it has been introduced into most tropical countries. This grass is of recent introduction here and, though but little information is as yet available regarding its behaviour in this country, results to date at the Experimental Plantation, Serdang, indicate it as a fodder crop of probable value in Malaya.

Propagation.—Seeds are produced in this country and germinate readily, though the most convenient method of propagation is by the use of stalks as in the case of sugar cane cultivation. Well-matured canes should be selected and cut into lengths with two joints, cutting about an inch beyond each joint. On average land the planting distance should be about 5 feet by 5 feet square.

Cultivation.—The land to be planted should be well cultivated and the soil reduced to a fine tilth. Planting should be carried out during wet weather to ensure the cuttings making a good start. The joints should be pushed into the ground with the upper end flush with the surface.

The first cutting is ready to be taken in six months time from planting and subsequent cuttings may be taken every four to six months according to season. When mature Napier Grass becomes woody, thus frequent cuttings are necessary to avoid this. No definite records are as yet available in this country as to the yield from this grass. It is estimated that at least 60 tons of fresh fodder per annum can be obtained under average conditions though this might often be exceeded.

Further experiments are required to test the palatableness of this grass to cattle under local conditions. A preference is shown for softer grasses, but this is thought to be due to the fact that so far the fodder has been fed too old. The United States Department of Agriculture state* that Napier grass is eaten eagerly by all kinds of farm cattle.

Merker grass is a variety of Napier grass that differs in having a more slender and glaucous stalk; it stands more erect and has slightly narrower leaves. The flower spikes appear earlier than those of Napier grass. Of the two varieties, Merker grass gives the lower yield of green fodder.

Pasture Land.

The amount of work and the expense incurred in laying down a pasture of pure grass in this country are heavy and experience to date causes considerable doubt as to whether it is an economic proposal. Two imported grasses have so far shown themselves of value for this purpose, but other grasses of likely value are under

* Farmers' Bulletin No. 1254, p. 25. Washington, U.S.A.

trial. The difficulty experienced is to find suitable grasses with a sufficiently close habit to exclude undesirable weeds and other grasses. Dallis grass and carpet grass have so far been found fairly satisfactory in this respect. Experiments to date have shown that it is very difficult to secure a good pasture by means of seed. There are a number of factors causing this, the principal of which are the presence of numerous ants which remove the seed and the heavy rains frequently experienced in this country. The most satisfactory means of establishing a pasture is by means of dibbling in divisions or runners on a prepared surface.

DALLIS GRASS, *PASPALUM DILATATUM.*

This grass is stated to be a native of the Argentine, but is now cultivated throughout the Southern United States, and Australia and is known in Ceylon.

Dallis grass was introduced into the Peninsula about twenty years ago and Ridley writing in 1906* comments favourably on it as a pasture grass. It does not, however, appear to have become naturalised, probably, because the damp, warm, conditions of this region are unfavourable to its spread by means of seed. It is a perennial, with a deep, strong root system and bunching habit of growth, attaining a height of 1½ to 2 feet.

Dallis grass is rather difficult to establish, as it does not spread by runners. Seeds should be sown in prepared beds and when the plants are of sufficient size, they should be lifted during suitable weather and split up into divisions. A suitable planting distance is about 1 foot apart each way. At first, growth is inclined to be patchy and frequently some supplying is necessary. It covers the land well in time and provided it is clean, little weeding is necessary.

Definite information as to the wearing qualities of this grass and subsequent treatment of the land are as yet not available.

According to the Department of Agriculture, Ceylon, the food units of Dallis grass are very high (l.c.). The analysis is given as under: —

		Per cent.
Water	-	61.10
Ash	-	3.18
Proteids	-	3.03
Carbohydrates	-	18.36
Nitrogen	-	.48
Woody fibre	-	10.00

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* Agric. Bull, S.S. & F.M.S. Vol. V, p. 113.

Seed of this grass is produced in quantity in Australia and is obtainable from Seed Merchants in that country. Sown broadcast, the seed rate is given at 10 lbs. per acre.

Carpet Grass, *Axonopus Compressus,*

Carpet grass is a native of the West Indies and is now employed extensively as a fodder grass in the Southern United States. It is a perennial pale-green grass, spreading by creeping stems which root at every joint, forming a close compact turf. The flower stems grow to a height of 1—1½ feet and are very slender. It is well suited for light soils. In the Gulf region of the U.S.A., it is said to stand close grazing and heavy trampling better than any other grass.

This species is of recent introduction at the Experimental Plantation, Serdang, and has shown itself a valuable acquisition. It is readily raised from imported seed, but, owing to its creeping habit, it is well adapted to propagation from runners. There is yet some doubt whether the quantity of fodder produced will warrant its extensive use as a grazing grass in Malaya, but its trial for this purpose is at present in progress.

Carpet grass is of considerable value as a general utility grass and, when kept closely cut, it forms an excellent turf. It is considered to be of possible use on the fairway of golf courses in the Peninsula, though too coarse as a grass for putting greens and tennis courts.

Summary.

(1) The present position of feeding cattle in this country is discussed.

(2) The results of stall feeding with various grasses obtained to date at the Experimental Plantation, Serdang, show Guinea Grass to be a suitable fodder. Trials with Mauritius Grass and Napier Grass are as yet incomplete.

(3) The question of establishing pastures is under experiment, and, so far, two imported grasses, namely, Dallis Grass and Carpet Grass have shown themselves promising.

Received for publication 15th September 1924.

A PRELIMINARY REPORT ON CARPET GRASS.

By J. Lambourne.

Carpet grass, also known as Louisiana grass, is a native of the West Indies, but is now distributed throughout the southern United States and from Mexico southward to Argentina and Chile. It is considered the most valuable grass known for permanent pastures on the sandy soils of the southern Coastal Plain region of the United States (1).

A small quantity of seed was received in 1921 from the Bureau of Plant Industry, United States Department of Agriculture, Washington. The seed was sown early in 1922 at the Experimental Plantation, Serdang, Selangor, and from the stock thus obtained it has been found possible to plant up a comparatively large area. Carpet grass soon established itself by natural seeding in several parts of the Experimental Plantation, though it has showed no signs of becoming a troublesome weed. At the time of writing, beside the trial plots, which are capable of supplying a large amount of planting material, the grass has been used to cover bare terraces and banks around the plantation bungalows and to form edges to roads and drains. In addition, cuttings have been supplied for trial at the golf course under construction at Frasers' Hill, Pahang, (alt: 4,000 feet) where it shows signs of being a suitable grass for 'through the greens.' Seed and cuttings have been distributed to various places in the Peninsula.

Carpet grass is a perennial, pale green, creeping species forming a dense turf, easily distinguished by the compressed two-edged creeping stems, rooting at each node, and by its linear, blunt tipped leaves. The inflorescence is digitate or subdigitate, borne on long slender peduncles from one or two feet long. Two or three flowering stems are produced from the terminal node and three, and sometimes four, spikes are carried at the tip of each peduncle. The first glume of the spikelet is wanting, and this, together with its flattened stem, blunt tipped leaves, and digitate or subdigitate inflorescence are the main distinguishing features.

There is as yet some uncertainty as to the correct nomenclature of Carpet grass and from information received from Prof. C. V. Piper, Senior Agronomist in Charge of the Bureau of Plant Industry, United States Department of Agriculture, it is hoped that the identity of this grass may be settled in the near future. The name *Axonopus compressus*, by which it is still known, has now been used for a similar grass, previously referred to by Ridley as *Paspalum platycaule*, Poir, (2). The latter grass, also a West Indian plant, though only differing in slight respects botanically from Carpet grass, presents considerable differences in habit when viewed growing side by side, and from an agronomical standpoint is much inferior. In the meantime, the more recent introduction may be referred to as *Axonopus compressus*, to which the name Carpet grass applies primarily.

Propagation and Cultivation.

The best method of propagation is by runners which are produced in abundance. These are dibbled into the soil, and within two months, providing the weather is moist, a good covering is formed, which if mown, forms a thick close turf very suitable for lawns or for 'through the greens' on golf courses.

Carpet grass is the best grass for this purpose in Malaya, so far seen by the writer, especially as it covers the land almost to the exclusion of all other grasses and weeds. Flowering stems are produced sparingly and the seeds have not the same objectionable characteristic as in the case of 'Love grass' (*Chrysopogon aciculatus*) which establishes itself on most lawns and golf courses in this country. It has not yet been ascertained whether Carpet grass will hold its own against Love grass, but judging by its strong growth, even on fairly poor soils, there is reason to think that it will do so.

On the trial plots at the Experimental Plantation, Serdang, this grass has been allowed to grow at will for over a year without cutting or weeding, except in the early stages of growth. On recent examination, it was found that only a few of the coarser grasses and a small amount of the Sensitive plant (*Mimosa pudica*), had established themselves amongst it. Where the grass had been mown regularly, however, it had remained practically pure.

Carpet grass may be propagated from seed, produced freely when the flowering stems are left uncut. The great difficulty is the collection of seed in quantity owing to depredations by rice birds.

As a grazing grass, there appear considerable possibilities for this species, though there is as yet some doubt whether the quantity of fodder produced will warrant its extensive use.

Soils.

In the Gulf States of the U.S.A., where it is grown extensively as a grazing grass, Carpet grass is said to be especially adapted to sandy loam soils, favouring land having moisture near the surface. On such soil, it will occupy the land in practically pure growth, especially under heavy grazing and trampling. At the Experimental Plantation, Serdang, it has been grown successfully on both sandy loam and lateritic soils. It appears to grow on any type of soil in this country if the moisture conditions are favourable. It stands up well during dry weather though making little growth during such periods.

References :—

(1) Farmers' Bulletin 1130, United States Department of Agriculture.

(2) Materials for a Flora of the Malay Peninsula, Monocotyledons, by H. N. Ridley, volume III.

Received for publication 3rd November 1924.

SOME OBSERVATIONS ON ROOT DISEASES OF HEVEA BRASILIENSIS.

A. SHARPLES.

TWO recent articles by Dr. C. van Overeem and Dr. C. van Overeem and Dr. A. Steinmann have to be recorded and considered in relation to our knowledge in Malaya. Regarding the article on "The Red-Root fungus of Hevea Brasiliensis," (2) the writer has been in communication with Dr. van Overeem and specimens have been exchanged. In this article Drs. van Overeem and Steinmann suggest that the fungus causing the well-known " Wet Rot" of Rubber roots in Malaya and named provisionally " *Fomes Psuedo-ferreus* " by Wakefield (1) from specimens developed in pure cultures by Belgrave, is the same as the fungus commonly found in West Java and named *Ganoderma ferreum* (Berkley) van Overeem and Steinmann ; and that " Wet Rot of Roots of Hevea Brasiliensis" in Malaya is the same as " Red Root of Hevea Brasiliensis" in Java.

In the interchange of specimens, old fruit-bodies from Belgrave's pure cultures were sent to Dr. van Overeem, who regarded the specimens as probably approximating to *Ganoderma ferreum*, although the typical spores were absent. The writer obtained from Dr. van Overeem typical fruit bodies of *Ganoderma ferreum* (Berkley) van Overeem and Steinmann, which appears to be found quite commonly in Java. The fructification sent by Dr. van Overeem has been examined closely by various authorities in Malaya and all are agreed that this fungus has never been found associated with Wet-Root Rot in Malaya. Pinching, Senior Officer on the Scientific Staff of the Rubber Growers' Association in Malaya however, has accepted *Ganoderma ferreum* in one of his latest articles (5).

In connection with the statement of Drs. van Overeem and Steinmann (l c.) " that this species should be called " *Ganoderma ferreum* (Berkley) van Overeem and Steinmann, and the name *Fomes psuedo-ferreus* (Wakefield) be considered synonymous" the writer considers that sufficient evidence has not been adduced to allow this statement to be accepted. Belgrave (1) in his investigation worked out the life-history of the fungus and its parasitic nature along the required lines, by obtaining pure cultures, successful inoculations and re-isolations. Drs. van Overeem and Steinmann have obtained much general field evidence regarding the identity of *Ganoderma ferreum* with a Wet Rot of Hevea roots in Java, but as regards actual proof, only to be obtained by pure culture work etc, they have offered no substantial evidence for regarding *Ganoderma ferreum* as synonymous with *Fomes psuedo-ferreus.*

To the layman, the question of naming may seem of small importance but there is a wider significance as a result of the writer's investigations on " Brown Root Disease" (6). Brown Root Disease is a factor of some importance in the cultivation of many tropical

crops and the causal fungus was usually assumed to be *Hymenochaetae noxia* (Berk) (4. p. 48) because this fungus was so commonly found associated with the disease; later Petch has changed this finding for Brown Root disease of *Hevea brasiliensis*, which he now regards as caused by *Fomes lamaoensis*, (Murr) *Hymenochaetae noxia* being a stage in the life history of *Fomes lamaoensis* (4.p.48). Again it should be remarked that as far as the literature has been studied, constant association of the fungus and diseased roots is the basis on which finding is made, and this evidence cannot be accepted as final. The writer studied comparatively:—

(1) Brown Root disease of Rubber roots from Ceylon.

(2) Brown Root disease of Rubber roots from Malaya.

(3) Brown Root disease of Camphor.

(4) Recently some work has been done on a Brown Root disease of *Aleurites montana*.

In these cases, four distinct fungi were isolated. The first three have all been inoculated into rubber seedlings and each one was capable of penetrating the tissues to a greater or less degree. Apart from the fungus obtained from Camphor roots suffering from Brown Root disease, all the fungi isolated, including that obtained from diseased roots of *Aleurites montana*. showed the same pecularities when grown in pure culture on rubber wood blocks. These were the rapid growth of the fungi in the tissuses of blocks, as shown by a copious exudation of drops of a clear gummy or resinous nature, and by the copious production of mucilage in contact with water. The fungus from Camphor Brown Root was out of line because of a yellowish-brown mycelium, which grew rapidly over the blocks to completely cover them.

The observations made in Malaya furnish strong evidence for considering that more than one fungus is concerned in causing Brown Root disease on the varied tropical cultivations. The characteristic symptoms of Brown Root disease, i.e. binding together of masses of loose soil and small debris into a firm mass around diseased roots, without doubt would be brought about by any fungus possessing the power of attacking the wood and producing mucilage when in contact with sufficient supplies of moisture; in effect there are many different morphological species of fungi cabable of causing Brown Root symptoms because they are similar in the physiological attributes.

A similar explanation appears more feasible to the writer regarding Red Root disease of Java, and "Wet Rot of Rubber in Malaya" i.e. probably two different fungi producing similar symptoms. Drs. van Overeem and Steinmann however, should have no difficulty in clinching the matter if pure cultures of *Ganoderma ferreum* are set up, when a comparison of the fruit-bodies, which appeared frequently in Belgrave's pure culture work, could be made and all further doubts set at rest,

The second article (3) by Dr. van Overeem is of interest in dealing with the fungus *Ustulina zonata* (Lev) Sacc which is responsible for many losses in rubber plantations.

Ustulina vulgaris Tul. and *Ustuliua zonata* (Lev) Sacc have up to date always been considered two different species. *Ustulina vulgaris* is known to occur frequently all over the world and is a genuine cosmopolitan, whereas *Ustulina zonata* is only known to occur in Tropical Asia (India, Ceylon, Malay Archipelago). Dr. van Overeem, in an extensive resume, has provided strong evidence for considering the two species identical and suggests the name *Ustulina maxima* (Web) von Wettstein, to include *Ustulina vulgaris* and *Ustulina zonata* which were previously considered distinct species.

Apart from the scientific interest, there is a practical aspect in regard to Dr. van Overeem's paper. He mentions the extraordinary variability of the tropical form of *Ustulina maxima* (Web) von Wettstein (i.e. U. zonata), a feature which was stressed by the writer (7). Petch (4 p. 144) in Ceylon and the mycologists of the Rubber Growers' Association in Malaya have called attention to the fungus *Kretzschmaria micropus*, which is given as a wound parasite on *Hevea brasiliensis.* The writer (7) and now Dr. van Overeem have both called particular attention to the "Kretzschmaria" stage of *Ustulina zonata,* for it is often found both in pure cultures and in close association with the ordinary plate-like form of the fungus in nature. No good can accrue to the rubber industry by unnecessarily multiplying the number of names of fungi supposed to be capable of causing diseases of *Hevea brasiliensis* and there seems no adequate reason in the present stage of our knowledge for considering the "Kretzschmaria" fungus associated with symptoms similar to those attributed to *Ustulina zonata* as other than an expression of the extreme variability in the growth forms of this fungus.

(1) Belgrave, W. N. C. - A Wet-Rot of Para Rubber Bull. No. 28, Dept. of Agr., F.M.S.

(2) Overeem van, C. Dr. and Steinmann, A. Dr. - Over De Roode Worteschimmel van *Hevea Brasiliensis* : M.A. Archief voor de Rubber Culture. Oct. 1923.

(3) Overeem van, C. Dr. - Uber *Ustulina vulgaris* Tul. und *Ustulina zonata* (Lev.) Sacc. Bull. du. Jardin Botanique Buitenzorg—Serie III, Vol. VI, Juillet 1924.

(4) Pinching, H. C. - A consideration of the present condition of the earliest Hevea plantings in the East. Report of Int. Rubber Conference. Brussels, published by Rubber Growers' Association.

(5) Petch, T. - Diseases and Pests of the Rubber Tree. 1921. Macmillan & Co.

(6) Sharples, A. - A preliminary account of Observations on the Fungi causing Brown Root Disease.
Malayan Agricultural Journal, Vol. X, July 1922, No. 7.

(7) Sharples, A. - *Ustulina zonata* (Lev.) Sacc. Anns: of App: Biology, No. 4, March 1918.

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Abstract of Meteorological Readings in the various Districts of Malaya for the Month of January, 1924.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru -	...	144.42	79.2	86.0	73.0	13.0	74.5	.764	71.2	76.	...	5.27	2.44
Pahang, Kuala Lipis -	...	...	78.5	87.5	72.5	15.0	75.	...	...	...	...	12.24	3.23
Johore, Johore Bahru -	...	...	...	86.61	72.77	...	...	...	...	...	...	8.16	1.50
Singapore, Kandang Kerbau -	1016.4	...	81.5	87.9	73.0	...	77.1	.758	...	81.3	N.	6.96	1.81
Malacca, Durian Daun -	1018.0	123.	82.	89.	73.	16.0	79.	.978	...	86.	N.E.	2.48	.55
Negri Sembilan, Seremban -	...	152.8	81.4	90.6	71.3	19.3	77.4	.863	74.7	81.06	N.W.	5.12	1.38
,, Kuala Pilah -	...	140.9	80.16	86.4	69.9	16.5	76.8	.846	74.2	83.2	...	9.45	2.37
,, Port Dickson -	...	155.3	81.8	87.03	73.7	13.3	77.3	.852	74.3	80.5	...	5.71	1.97
Selangor, Kuala Lumpur -	...	...	81.6	87.3	72.3	16.0	76.8	.833	73.5	76	Calm	5.83	1.87
,, Klang -	...	...	80.2	85.6	74.3	11.3	...	...	...	...	...	8.46	1.37
,, Kuala Selangor -	...	...	...	88.4	...	...	...	...	...	...	...	12.05	3.77
,, Rawang -	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson -	...	...	81.21	88.6	72.3	16.2	76.91	.855	...	78.	...	12.2	2.76
,, Ipoh -	...	...	81.60	90.5	72.7	17.8	76.45	.856	72.99	82.	...	10.82	5.19
,, Taiping -	...	...	81.64	88.3	73.9	14.4	77.73	.899	...	85.	...	23.5	5.51
,, The Cottage -	...	...	...	...	...	...	...	...	...	...	...	11.82	3.77
,, Parit Buntar -	...	...	82.04	89.9	71.6	18.3	77.82	.897	...	83.	...	2.37	.98
Penang, George Town -	1008.7	161.	82.8	94.	68.	26.	79.3	.951	70.1	84.2	N.W.	4.33	1.46
Kedah, Alor Star -	...	...	...	...	...	...	...	...	...	...	...	2.02	1.66
Perlis, Kangar -	...	...	...	84.65	70.95	...	...	...	...	...	...	2.78	2.67

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of February, 1924.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Maximum.	Minimum.	Range.	Hygrometer. Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru -	...	146.30	81.0	89.93	73.37	15.65	75.60	.782	71.90	74.	...	6.82	1.95
Pahang, Kuala Lipis -	...	...	80.7	89.96	73.2	16.4	76.1	...	...	...	...	7.05	1.63
Johore, Johore Bahru -	...	...	...	88.55	73.10	...	...	...	...	...	...	20.13	4.00
Singapore, Kandang Kerbau -	1014.4	...	82.8	88.2	73.4	...	77.9	.787	...	84.2	Calm	19.72	4.68
Malacca, Durian Daun -	1017.8	116.	82.	88.	73.	15.	80.	1.003	...	88.	N.E.	10.03	2.39
Negri Sembilan, Seremban -	...	152.9	80.9	89.9	71.8	18.1	76.6	.840	73.8	80.1	N.W.	5.58	1.02
,, Kuala Pilah -	...	140.27	80.69	87.69	70.55	17.14	77.03	.856	74.52	82.89	...	3.96	1.16
,, Port Dickson -	...	157.9	81.3	87.5	74.2	13.3	76.1	.850	74.8	80.30	...	5.59	1.34
Selangor, Kuala Lumpur -	...	151.8	82.4	89.6	72.4	17.2	76.6	.808	72.8	74.	Calm	5.51	1.05
,, Klang -	...	...	80.3	86.0	74.8	11.2	77.1	...	...	...	...	8.46	2.34
,, Kuala Selangor -	...	...	...	89.9	...	...	...	...	...	...	...	9.01	4.83
,, Rawang -	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson -	...	...	81.97	89.1	73.2	15.9	78.07	.909	...	85.		13.19	2.76
,, Ipoh -	...	...	82.63	92.2	72.7	19.5	76.87	.847	73.27	77.		4.96	1.40
,, Taiping -	...	...	82.39	88.9	74.1	14.8	78.15	.906	...	83.	...	14.29	2.43
,, The Cottage -	...	...	...	...	...	...	...	...	...	...	...	6.77	1.21
,, Parit Buntar -	...	...	82.83	90.6	73.1	17.5	77.75	.883	...	79.	...	7.51	2.59
Penang, George Town -	1012.8	161.	82.3	92.	73.	19.	79.3	.965	70.7	87.9	N.W.	3.21	1.01
Kedah, Alor Star -	...	...	...	...	...	...	...	...	...	...	...	3.18	1.60
Perlis, Kangar -	...	...	...	91.79	72.89	18.90	...	...	...	...	...	7.94	2.76

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of March. 1924.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Maximum.	Minimum.	Range.	Hygrometer. Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	143.35	80.70	87.32	73.80	13.51	75.70	.793	70.30	76.	...	21.41	5.65
Pahang, Kuala Lipis	...	...	81.00	88.8	73.5	15.3	76.6	...	...	...	...	10.76	3.04
Johore, Johore Bahru	...	...	...	87.74	73.45	...	...	...	...	...	...	15.36	2.24
Singapore, Kandang Kerbau	1014.5	...	81.6	87.8	73.3	...	77.6	.762	...	83.3	Calm	14.53	3.57
Malacca, Durian Daun	1017.7	122.	83.	89.	74.	15.	81.	1.035	...	87.	N.E.	5.73	1.64
Negri Sembilan, Seremban	...	159.09	81.0	90.22	72.87	17.35	76.5	.828	73.5	78.8	N.W.	7.04	1.77
,, Kuala Pilah	...	129.22	81.52	89.42	71.93	17.49	77.58	.867	75.0	81.79	...	5.92	1.64
,, Port Dickson	...	158.2	83.3	88.4	74.6	13.8	78.	.869	74.9	79.0	...	3.45	.95
Selangor, Kuala Lumpur	...	...	81.8	90.1	73.1	17.0	77.1	.846	74.1	78	...	12.12	2.54
,, Klang	...	...	80.3	85.8	75.0	10.8	77.3	...	...	...	...	9.67	2.52
,, Kuala Selangor	...	...	...	89.7	...	...	...	...	...	...	...	4.96	1.64
,, Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	81.88	89.7	73.4	16.3	78.85	.941	...	87.	...	24.83	5.14
,, Ipoh	...	...	81.55	91.3	73.4	17.9	77.0	.868	73.6	81.	...	10.85	2.59
,, Taiping	...	...	82.02	89.8	74.2	15.6	78.11	.912	...	85.	...	31.64	6.52
,, The Cottage	...	...	...	...	...	...	...	...	...	...	...	26.21	3.65
,, Parit Buntar	...	...	82.96	90.6	73.7	16.9	78.39	.926	...	81.	...	15.4	3.33
Penang, George Town	1008.5	155.	82.8	94.	70.	24.	79.3	.941	70.	81.3	S & N W.	12.59	5.14
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	6.48	2.32
Perlis, Kangar	...	...	...	91.70	73.51	18.19	...	...	...	...	...	4.49	.85

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of April, 1924.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	147.95	83.7	91.36	75.33	16.03	77.3	.812	73.0	70.	...	1.33	0.67
Pahang, Kuala Lipis	...	...	82.4	89.5	74.0	15.5	77.2	...	...	...	...	10.97	2.64
Johore, Johore Bahru	...	...	...	89.6	74.2	...	...	...	...	...	...	11.84	3.52
Singapore, Kandang Kerbau	1013.8	...	83.9	88.9	74.4	...	79.	.778	...	80.	Calm	3.72	1.62
Malacca, Durian Daun	1017.6	124.	84.	89.	75.	14.	81.	1.043	...	87.	N.E.	6.27	2.36
Negri Sembilan, Seremban	...	156.96	80.95	90.8	72.9	17.9	77.03	.800	74.54	81.43	N.W.	12.34	3.31
„ Kuala Pilah	...	138.13	82.52	90.52	71.77	18.73	78.41	.888	75.68	80.88	...	10.47	3.32
„ Port Dickson	...	159.2	82.96	89.1	74.86	14.27	78.5	.879	75.7	79.2	...	12.13	5.11
Selangor, Kuala Lumpur	...	150.6	82.7	90.6	73.3	17.3	78.	.859	74.6	81.	N.E.	12.91	2.43
„ Klang	...	...	81.1	86.6	75.2	11.4	80.8	...	...	...	...	9.96	3.38
„ Kuala Selangor	...	...	...	90.2	...	...	...	...	...	...	...	12.37	3.81
„ Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	82.66	90.5	74.7	15.8	78.61	.917	...	81.	...	6.84	1.60
„ Ipoh	...	...	81.86	92.3	74.	18.3	77.55	.887	75.32	83.	...	10.71	2.91
„ Taiping	...	...	82.91	90.7	74.4	16.3	79.03	.942	...	85.	...	14.25	2.04
„ The Cottage	...	...	...	...	...	...	...	...	...	...	...	27.52	4.29
„ Parit Buntar	...	...	82.60	90.4	73.1	17.3	78.76	.931	...	85.	...	11.26	3.38
Penang, George Town	1008.6	152.	80.5	94.	70.	24.	78.2	.870	69.9	89.8	N.W.	10.39	3.54
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	6.60	2.20
Perlis, Kangar	...	...	...	90.93	74.20	16.73	...	...	...	...	...	5.55	1.39

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of May, 1924.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru -	...	142.85	84.0	91.64	75.38	16.25	76.9	.790	72.2	67.	...	4.41	2.04
Pahang, Kuala Lipis -	...	...	81.8	89.4	74.4	15.0	77.	...	...	...	...	17.55	3.53
Johore, Johore Bahru -	...	...	...	88.22	74.45	....	...	...	...	...	...	8.82	1.92
Singapore, Kandang Kerbau -													
Malacca, Durian Daun -	1017.6	121.	84.	88.	75.	13.	81.	1.055	...	89.	N.E.	6.73	1.10
Negri Sembilan, Seremban -	...	158.03	80.66	90.29	73.35	16.9	76.9	.850	74.35	81.4	N.W.	10.31	2.19
„ Kuala Pilah -	...	129.29	82.25	90.45	72.48	17.97	78.61	.902	76.36	82.78	...	8.98	1.89
„ Port Dickson -	...	155.1	82.73	88.2	75.0	13.2	78.1	.884	75.8	78.6	...	4.52	1.16
Selangor, Kuala Lumpur -	...	145.7	81.1	89.9	74.2	15.7	77.5	.871	76.1	84.	Calm	14.14	2.86
„ Klang -	...	...	80.3	85.9	75.3	10.6	77.2	...	...	...	...	6.71	1.54
„ Kuala Selangor -	...	...	...	89.6	...	...	...	...	...	...	...	7.54	2.68
„ Rawang -	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson -	...	...	82.15	89.2	75.0	14.2	78.88	.942	...	87.	...	10.75	2.25
„ Ipoh -	...	...	81.30	90.9	74.7	16.2	77.67	.899	75.06	85.	...	11.3	3.07
„ Taiping -	...	...	82.56	89.6	75.4	14.2	79.19	.952	...	87.	...	7.64	1.8
„ The Cottage -	...	...	...	...	...	...	...	...	...	...	...	24.63	4.74
„ Parit Buntar -	...	...	82.96	90.9	73.4	17.5	79.17	.946	...	85.	...	9.53	4.6
Penang, George Town -	1008.7	156.	81.3	94.	69.	25.	79.5	.968	70.4	87.6	N.W.	7.66	2.43
Kedah, Alor Star -	...	...	...	...	...	...	...	...	...	...	...	11.98	2.40
Perlis, Kangar -	...	...	...	88.87	74.87	14.	...	...	...	...	...	8.68	1.86

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of June, 1924.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bahru -	...	143.05	83.1	91.33	74.36	16.96	76.4	.782	71.9	69.	...	8.38	3.15
Pahang, Kuala Lipis -	...	...	81.5	89.3	74.5	14.8	77.0	...	...	...	...	4.71	1.72
Johore, Johore Bahru -	...	...	...	87.66	73.90	...	...	...	...	...	...	7.88	1.57
Singapore, Kandang Kerbau -													
Malacca, Durian Daun -	1017.6	120.	83.	87.	74.	13.	81.	1.040	...	89.	N.E.	5.43	1.25
Negri Sembilan, Seremban -	...	153.1	80.1	89.8	71.8	18.	76.9	.864	74.5	84.2	N.W.	5.43	2.19
,, Kuala Pilah -	...	...	81.6	89.4	70.7	18.7	77.8	.876	75.2	81.7	...	6.12	1.64
,, Port Dickson -	...	155.1	81.2	87.4	74.4	13.	77.3	.881	75.2	80.0	...	9.67	3.61
Selangor, Kuala Lumpur -	...	144.7	80.7	89.3	72.8	16.5	77.4	.852	74.5	82.	Calm	5.11	2.03
,, Klang -	...	...	81.0	86.0	74.9	11.1	77.6	...	...	...	...	3.1	2.31
,, Kuala Selangor -	...	...	...	90.2	...	...	...	...	...	...	...	1.21	.85
,, Rawang -	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson -	...	...	81.97	88.7	73.6	15.1	78.28	.918	...	85.	...	2.63	.79
,, Ipoh -	...	...	83.37	91.2	72.9	18.3	77.11	.839	73.75	77.	...	12.82	4.47
,, Taiping -	...	...	82.50	89.9	73.7	16.2	77.84	.891	...	82.	...	6.45	1.81
,, The Cottage -	...	...	...	...	...	...	...	...	...	...	...	26.91	2.75
,, Parit Buntar -	...	...	83.35	91.1	72.8	18.3	78.88	.926	...	84.	...	3.01	1.05
Penang, George Town -	1008.8	150.	84.7	94.	68.	26.	71.	.929	69.5	83.6	S.	6.16	.89
Kedah, Alor Star -	...	...	...	...	...	...	...	...	...	...	...	12.97	1.93
Perlis, Kangar -	...	...	...	89.06	74.6	14.46	...	...	...	...	...	4.62	.73

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of July, 1924.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	143.66	82.6	90.67	74.67	16.00	76.7	.804	72.7	72.	...	4.49	1.17
Pahang, Kuala Lipis	...	...	81.8	89.9	75.2	14.7	76.7	...	...	...	...	.60	.22
Johore, Johore Bahru	...	...	...	87.93	73.64	...	...	...	...	...	...	7.96	1.91
Singapore, Kandang Kerbau													
Malacca, Durian Daun	1017.4	118.	83.	87.	74.	13.	81.	1.043	...	90.	N.E.	8.73	1.88
Negri Sembilan, Seremban	...	149.7	80.03	90.2	72.3	17.9	77.26	.879	75.36	85.83	S.E.	4.98	1.6
„ Kuala Pilah	...	...	82.01	89.68	70.42	19.26	76.98	.842	73.34	76.86	...	4.81	1.77
„ Port Dickson	...	153.5	81.76	87.1	74.3	12.8	77.45	.852	74.3	78.43	...	8.53	1.8
Selangor, Kuala Lumpur	...	146.9	81.3	89.5	72.4	17.1	76.2	.807	72.8	79.	Calm	5.73	2.43
„ Klang	...	...	81.2	85.5	74.3	11.2	76.8	...	...	...	...	8.61	2.82
„ Kuala Selangor	...	...	...	90.2	...	...	...	...	...	...	...	7.3	2.16
„ Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	81.56	88.6	73.1	15.5	77.47	.887	...	83.	...	4.47	1.29
„ Ipoh	...	...	81.37	91.2	72.8	18.4	76.91	.868	73.42	82.	...	8.22	3.57
„ Taiping	...	...	83.42	90.2	74.4	15.8	77.85	.879	...	77.	...	7.90	2.59
„ The Cottage	...	...	...	...	...	...	...	...	...	...	...	10.89	1.44
„ Parit Buntar	...	...	82.77	90.5	72.4	18.1	77.97	.886	...	81.	...	14.59	10.02
Penang, George Town	1008.9	153.	82.3	93.	70.	23.	79.	.930	71.3	81.6	S.	6.6	1.96
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	7.28	2.85
Perlis, Kangar	...	...	...	88.58	74.97	13.61	...	...	...	...	...	7.09	2.03

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of August, 1924.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	147.5	82.9	91.38	74.0	17.38	76.1	.774	71.6	68.	...	4.04	1.24
Pahang, Kuala Lipis	...	...	82.5	91.8	74.7	17.1	76.2	...	...	...	...	1.32	0.42
Johore, Johore Bahru	...	...	...	87.38	74.12	...	...	...	...	...	...	6.20	1.81
Singapore, Kandang Kerbau													
Malacca, Durian Daun	1017.4	120.	83.	87.	74.	13.	80.	1.030	...	88.	N.E.	13.87	4.16
Negri Sembilan, Seremban	...	147.9	80.5	90.9	70.7	20.2	77.2	.875	75.2	85.	S.E.	4.19	1.57
,, Kuala Pilah	...	...	82.08	90.66	70.01	20.65	76.74	.816	73.3	75.87	...	3.9	1.74
,, Port Dickson	...	151.2	81.5	86.54	73.96	12.58	77.2	.849	74.2	79.4	...	7.1	1.44
Selangor, Kuala Lumpur	...	146.5	81.4	89.6	72.3	17.3	76.1	.800	72.5	78.2	Calm	1.97	1.87
,, Klang	...	...	81.5	86.3	74.2	12.1	76.6	...	...	...	...	4.32	1.4
,, Kuala Selangor	...	...	...	90.6	...	...	...	...	...	...	...	2.36	1.4
,, Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	82.57	90.2	73.8	16.4	77.61	.882	...	81.	...	.96	.54
,, Ipoh	...	...	82.14	91.7	73.1	18.6	77.07	.862	73.45	79.	...	3.61	.98
,, Taiping	...	...	82.92	91.5	73.8	17.7	78.11	.899	...	81.	...	10.56	2.43
,, The Cottage	...	...	...	...	...	...	...	...	...	...	...	11.92	1.68
,, Parit Buntar	...	...	83.13	90.0	72.1	17.9	78.24	.902	...	81.	...	6.95	3.11
Penang, George Town	1008.6	154.	80.1	93.	70.	23.	77.1	.892	69.8	85.6	S.	6.48	3.07
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	13.87	2.83
Perlis, Kangar	...	...	...	88.32	74.32	14.	...	...	...	...	...	11.81	2.15

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of September, 1924.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bahru -	...	147.09	81.7	90.6	74.2	16.4	75.8	.779	71.8	72.	...	3.23	1.28
Pahang, Kuala Lipis -	...	...	80.9	89.2	73.9	15.3	75.8	...	...	...	...	9.91	2.74
Johore, Johore Bahru -	...	...	...	87.03	73.83	...	...	...	...	...	...	17.67	3.63
Singapore, Kandang Kerbau -													
Malacca, Durian Daun -	1017.6	112.	83.	87.	74.	13.	80.	1.017	...	90.	N.E.	11.24	1.89
Negri Sembilan, Seremban -	...	144.6	80.1	88.9	67.3	21.6	76.3	.835	73.8	82.	S.E.	9.08	2.12
,, Kuala Pilah -	...	...	81.35	88.93	70.10	18.83	76.4	.816	73.09	77.18	...	2.91	1.29
,, Port Dickson -	...	150.7	80.5	85.6	73.5	12.1	77.1	.850	74.2	82.1	...	14.72	3.45
Selangor, Kuala Lumpur -	...	147.0	79.6	87.3	72.4	14.9	75.4	.808	72.7	82.5	Calm	7.17	2.15
,, Klang -	...	...	79.9	84.3	73.7	10.6	76.2	...	...	...	...	9.12	3.15
,, Kuala Selangor -	...	...	...	88.8	...	...	...	...	...	...	...	6.4	1.37
,, Rawang -	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson -	...	...	80.26	88.	73.	15.	73.53	.739	...	72.	...	9.08	2.67
,, Ipoh -	...	...	80.34	89.2	72.6	16.6	76.47	.861	73.86	85.	...	12.79	3.34
,, Taiping -	...	...	81.02	88.9	72.4	16.5	77.	.875	...	83.	...	12.31	1.74
,, The Cottage -	...	...	...	...	...	...	...	...	...	...	...	35.14	3.45
,, Parit Buntar -	...	...	81.83	89.6	70.7	18.9	77.54	.888	...	83.	...	13.06	2.94
Penang, George Town -	1009.2	150.	81.7	92.	68.	24.	78.2	.926	70.2	85.9	S.	14.95	3.06
Kedah, Alor Star -	...	...	...	...	...	...	...	...	...	...	...	11.31	2.40
Perlis, Kangar -	...	...	...	87.13	73.70	13.43	...	...	...	...	...	8.95	1.73

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of October, 1924.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru -	...	147.33	81.2	90.25	74.45	15.80	75.0	.754	70.8	70.	...	7.65	2.00
Pahang, Kuala Lipis -	...	...	80.8	88.8	72.7	16.1	75.8	...	...	...	...	13.97	2.22
Johore, Johore Bahru -	...	...	...	88.83	73.96	...	...	...	...	...	...	5.94	1.18
Singapore, Kandang Kerbau -													
Malacca, Durian Daun -	1017.4	114.	83.	88.	74.	14.	81.	1.039	...	89.	N.W.	9.57	1.99
Negri Sembilan, Seremban -	...	146.9	81.1	89.5	70.9	18.6	76.7	.837	75.2	79.9	S.W.	5.00	1.18
„ Kuala Pilah -	...	...	81.4	89.	70.1	18.9	76.27	.809	72.89	76.25	...	5.27	1.60
„ Port Dickson -	...	155.3	81.3	86.5	74.4	12.1	76.9	.843	73.2	77.36	...	6.84	1.67
Selangor, Kuala Lumpur -	...	144.4	80.7	88.1	72.7	15.3	75.7	.798	72.4	79.4	Calm	5.44	1.18
„ Klang -	...	...	80.4	85.1	74.5	10.6	77.6	...	...	...	...	3.15	1.57
„ Kuala Selangor -	...	...	...	88.9	...	...	...	...	...	...	...	3.34	.75
„ Rawang -	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson -	...	...	80.34	87.2	73.1	14.1	78.21	.938	...	91.	...	6.89	1.4
„ Ipoh -	...	...	80.38	89.	72.5	16.5	76.63	.868	73.63	85.	...	13.15	2.12
„ Taiping -	...	...	78.11	88.1	73.2	14.9	76.98	.871	...	82.	...	11.54	1.70
„ The Cottage -	...	...	...	...	...	...	...	...	...	...	...	44.64	7.71
„ Parit Buntar -	...	...	81.37	88.3	73.1	15.2	78.12	.921	...	87.	...	10.82	3.70
Penang, George Town -	1009.3	158.	81.5	92.	68.	24.	78.3	.927	70.7	86.5	N.W.	29.95	9.47
Kedah, Alor Star -	...	...	...	...	...	...	...	...	...	...	...	11.31	2.68
Perlis, Kangar -	...	...	...	85.22	74.45	10.77	...	...	...	...	...	8.80	1.61

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of November, 1924.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru -	...	143.33	78.8	86.96	73.13	13.83	74.2	.759	71.0	77.	...	25.06	12.80
Pahang, Kuala Lipis -	...	...	79.1	85.9	72.8	13.1	75.3	...	...	...	...	6.55	1.1
Johore, Johore Bahru -	...	...	...	86.86	73.06	...	...	...	...	...	...	9.12	2.78
Singapore, Kandang Kerbau -													
Malacca, Durian Daun -	1017.6	113.	82.	87.	74.	13.	80.	1.031	...	90.	N.E.	4.00	.95
Negri Sembilan, Seremban -	...	140.6	81.0	88.1	73.3	14.8	76.5	.828	73.8	79.2	S.W.	4.59	.59
„ Kuala Pilah -	...	...	80.2	86.8	70.4	16.4	75.9	.814	73.0	79.5	...	13.21	2.87
„ Port Dickson -	...	147.7	80.5	85.1	72.6	12.6	77.3	.857	74.5	81.7	...	4.78	.78
Selangor, Kuala Lumpur -	...	142.4	79.7	87.1	72.6	14.5	75.7	.813	73.	82.8	Calm	7.30	2.56
„ Klang -	...	...	81.0	84.9	74.6	10.3	77.9	...	...	...	...	5.32	3.07
„ Kuala Selangor -	...	...	...	88.6	...	...	...	...	...	...	...	7.07	1.84
„ Rawang -	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson -	...	...	80.07	86.8	73.0	13.9	77.42	.906	...	89.	...	11.17	3.82
„ Ipoh -	...	...	79.59	88.	72.4	15.6	75.61	.836	73.92	84.	...	12.88	3.43
„ Taiping -	...	...	80.41	87.5	72.5	15.	76.90	.879	...	85.	...	10.94	2.33
„ The Cottage -	...	...	...	...	...	...	...	...	...	...	...	26.26	3.73
„ Parit Buntar -	...	...	81.57	90.2	71.8	18.4	77.51	.890	...	83.	...	11.54	3.38
Penang, George Town -	1008.9	152.	81.2	90.	69.	39.	78.3	.927	70.4	86.8	N.W.	11.12	2.91
Kedah, Alor Star -	...	...	...	...	...	...	...	...	...	...	...	7.41	1.35
Perlis, Kangar -	...	...	...	84.26	72.53	11.73	...	...	...	...	...	6.10	1.72

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of December, 1924.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	141.33	77.4	84.03	72.03	12.00	72.90	.728	69.8	77.	...	14.89	3.95
Pahang, Kuala Lipis	...	...	77.9	83.9	71.3	12.6	74.0	...	...	...	...	13.05	3.16
Johore, Johore Bahru	...	...	...	85.58	71.7	...	...	...	...	...	...	7.64	1.78
Singapore, Kandang Kerbau													
Malacca, Durian Daun	1017.5	121.	82.	88.	73.	15.	79.	1.003	...	89.	N.E.	6.72	2.25
Negri Sembilan, Seremban	...	140.1	81.5	87.6	72.8	14.3	77.1	.837	74.2	78.9	S.W.	5.74	2.43
,, Kuala Pilah	...	...	79.9	86.2	69.1	17.1	75.9	.780	71.7	77.0	...	4.54	.81
,, Port Dickson	...	154.8	80.3	85.2	73.2	12.0	76.0	.812	72.9	79.2	...	7.48	2.47
Selangor, Kuala Lumpur	...	149.3	79.4	86.9	71.2	15.6	73.7	.758	70.9	78.4	Calm	4.38	1.54
,, Klang	...	...	77.5	83.8	73.2	10.5	76.3	...	...	...	...	2.60	1.11
,, Kuala Selangor	...	...	...	88.8	...	...	...	...	...	...	...	7.87	2.76
,, Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	78.01	87.22	72.23	15	76.10	.878	...	93.	...	5.11	.91
,, Ipoh	...	...	79.64	89.30	71.45	17.8	75.48	.827	72.45	82.	...	16.13	3.64
,, Taiping	...	...	79.24	86.80	72.28	14.5	76.49	.874	...	89.	...	14.49	1.98
,, The Cottage	...	...	...	...	...	...	...	...	...	...	...	23.31	5.24
,, Parit Buntar	...	...	81.33	89.29	71.55	17.7	77.13	.876	...	83.	...	5.92	1.25
Penang, George Town	1008.6	152.	81.9	91.	70.	21.	73.6	.926	70.8	84.	N.	2.68	.81
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	1.27	1.08
Perlis, Kangar	...	...	...	84.77	70.64	14.13	...	...	...	...	...	1.49	1.06

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FURTHER STUDIES ON JELUTONG.[1]

By V. R. Greenstreet.

THE production of jelutong in the F.M.S. has increased from only 100 pikuls[2] in 1922 to over to 2,000 pikuls in 1923, while during the latter year a total of 50,000 pikuls with a value of nearly a million dollars passed through Singapore. Nearly all this was shipped to the U.S.A. where it is in growing demand as a cheap substitute for West Indian chicle in the manufacture of chewing gum. The bulk of the jelutong of commerce is derived from Sarawak and the Netherland Indies where however owing to crude methods of preparation and lack of transport facilities, wastage due to deterioration is enormous. It is confidently asserted by the Singapore representative of an important New York firm of jelutong dealers that it would be easily possible for British Malaya, by using standardised methods of preparation and by virtue of its efficient transport system, to capture the whole of this trade.

Methods of Preparation.

The customary coagulants for jelutong latex are kerosine oil, alum, sulphuric acid or methylated spirits. The physical condition of the coagulum depends upon whether it is pressed into a compact block or left to dry in the unpressed state. Unpressed coagulum although spongy is brittle and when fresh or preserved in water can retain up to 70 per cent. of moisture within its cells. On drying, such coagulum retains its honeycomb structure, but eventually falls to dust, in which condition it is resistant to wetting, exhibits none of the plastic properties of jelutong and is of no commercial value. The presence of kerosine oil prevents excessive loss of moisture. Although the effect of pressing the coagulum is to squeeze out a large amount of water, a certain proportion is retained very tenaciously to give a product which although brittle, exhibits when masticated with warm water, all the plastic properties of jelutong. Coagulation with kerosine oil has always been popular because the retention of so much water by the coagulum resulted in bigger profits. On the other hand, owing to the difficulty in eliminating the taste of kerosine from the finished chewing gum, many efforts have been directed towards discovering a method whereby a similar effect could be produced without the accompanying objectionable taste. This has led to the fabrication of innumerable "obat"[3] of secret formulae for treating crude unpressed jelutong

1. Jelutong. Eaton, B. J. & Dennett, J. H., Malayan Agricultural Journal, 1923, XI, 220.

2. Pikul = 133 pounds.

3. "obat": medicine (also applied to any mixture of chemicals)

coagulated with sulphuric acid or alum. The two principal constituents of those "obat" which the author has analysed are castor oil and ammonia, while each jelutong "refiner" adds a complicated mixture of incompatible chemicals having no scientific basis. After boiling with "obat" the jelutong is pressed into blocks and stored in water until a few days before packing. Jelutong prepared in this manner is put on the market as a "refined jelutong." In this connection it may be remarked that the density of "refined jelutong" is so little greater than unity that it has the interesting property of floating in hot water and sinking in cold water. Owing to the diversity in the composition of "obat," "refined jelutong" is a very variable product. Some brands are tasteless but in other respects very similar to that resulting from kerosine oil coagulation, while others soon dry to a useless and permanently crumbly powder. For this reason added to the fact that freight charges are thereby increased, "refined jelutong" is falling into disfavour. A high moisture content is moreover being discounted by dealers who now pay on a moisture free basis.

Experimental.—Samples of jelutong latex were coagulated using various coagulants, the results being recorded in Table I.

TABLE I.

No.	Name of coagulant.	Amount of coagulant. Parts per 1,000.	Time of coagulation. Days.	Description of hand pressed coagulum.
1	Anaerobic	...	3	hard: slight foul odour: good colour.
2	Aerobic	...	3	hard: slight foul odour: good colour.
3	Sodium silico-fluoride.	10	1	hard: no odour: very good colour.
4	Ammonia-alum	30	1	hard: no odour: good colour.
5	Acetic acid	1	1	hard: slight odour: good colour.
6	Sulphuric acid	0.5	½	hard: no odour: good colour.
7	Sugar	10	2	hard: slight foul odour: good colour.
8	Tannic acid	5	2½	hard: no odour: dark colour.
9	Sugar and tannic acid.	10+5	2	hard: slight foul odour: good colour.
10	Kerosine oil	25	1½	soft: odour of kerosine oil: fairly good colour.
11	Castor oil	25	3	soft: odour of castor oil: fairly good colour.

Although the first nine coagula were hard and brittle, none deteriorated to a crumbly powder, and when masticated with warm water regained their plasticity. The satisfactory physical condition

of a coagula Nos. 10 and 11 was discounted by their odour. From general considerations coagulation with sodium silicofluoride and sulphuric acid yielded the most satisfactory results.

GENERAL CHARACTERISTICS AND DEFECTS.

As a result of the examination of jeulutong prepared by the principal methods of coagulation and "refining", followed up by a discussion with manufacturers representatives, attention was focussed on the general defects to which jelutong is liable and which must be guarded against in the preparation of a standard product. These defects may be considered under the headings:—

1. Rate of drying.
2. Resinification.
3. Mould development.

Rate of drying.—As deterioration due to crumbling to a permanent powder appeared to be due to excessive auto-desiccation, it was decided to compare the rate of drying of samples prepared by direct coagulation, with that of "refined jelutong." Seven samples of jelutong were accordingly exposed to the drying action of an electric fan at room temperature for 1 month and weighed daily: a description of the samples is appended in Table II while the accompanying curve shows the diminution in moisture content due to evaporation.

TABLE II.

Description of jelutong samples examined for moisture retaining properties.

Sample No.	Treatment.	Keeping Qualities.
1	"Refined"	... good
2	"Refined"	... inferior
3	"Refined"	... bad
4	Coagulated with sodium silicofluoride: pressed	... good
5	Coagulated with sulphuric acid: pressed	... good
6	Coagulated with kerosine oil: pressed	... good
7	Coagulated with alum: unpressed	... bad

The curves show that one sample of "refined jelutong" (No. 2) has a water-retaining capacity comparable to that of kerosine oil coagulated jelutong (No. 6). Another sample of refined jelutong (No. 3) looses moisture at approximately the same rate as that directly coagulated with sulphuric acid (No. 5): deterioration set in however in sample No. 3 and not in sample No. 5. The sample coagulated with sodium silicofluoride (No. 4) dried still

further and yet showed no signs of deterioration, while in the unpressed sample coagulated with alum (No. 7) extreme desiccation is accompanied by deterioration. With a minimum moisture content of 5 per cent therefore, deterioration is not a function of desiccation, although a good moisture retaining capacity appears to be some criterion of satisfactory keeping properties.

Resinification.—Deterioration of jelutong is characterised by entire loss of cohesion and elasticity, while that of (unvulcanised) *Hevea* rubber is characterised by excessive tackiness. It has been shown however that the ultimate condition of deteriorated *Hevea* rubber is hard smooth and dry[4]. This phenomenon is marked by an increase in resin and oxygen content and occurs particularly under the catalytic influence of copper. Jelutong resign has been studied by Alexander[5] who found that its analysis corresponded to $C_{25}\ H_{40}O$. He regarded this as an oxidation product of caoutchouc having the constitution $(C_{10}H_{16})_5O_2$. Such being the case, the addition of 4.7 per cent. oxygen on its caoutchouc content (approximately 20-25 per cent.) that is one per cent. of oxygen on the total jelutong should be sufficient to resinify the whole of the caoutchouc fraction. It has been demonstrated however that in the case of *Hevea* rubber, susceptibility of the caoutchouc to oxidation varies inversely with the resin content[6]. This would lead us to expect jelutong caoutchouc to be particularly resistant to oxidation. Experiments were however carried out to test this hypothesis and discover: –

(a) if the results for the determination of moisture by drying to constant weight at 100°C in a current of air, and under reduced pressure are comparable.

(b) if the proportion of resin increases on drying at 100°C.

(c) how the proportion of resin changes with deterioration, and

(d) the effect of prolonged heating in a current of air and under reduced pressure on (1) the weight, and (2) the resin content.

Throughout these experiments the numbering adopted in table II was adhered to, while resin was determined by acetone extraction and recorded as a percentage on the dry weight.

TABLE III.

Moisture content of duplicate samples of jelutong dried at 100°C.

Method of drying.	Moisture per cent.
In a current of air ...	35.5
Under reduced pressure ...	35.55

4. Whitby G. S. Plantation rubber and the testing of rubber, 1920.
5. Gummi-Zeitung, 1904. 18. 867.
6. Peachy. Society of Chemical Industry Journal, 1912. 31. 1103. Kirchof. Kolloid Zeitschrift, 1913. 13. 49.

As identical results for loss of moisture are obtained by these two methods, subsequent resin estimations are comparable.

TABLE IV.

Resin content of duplicate samples of jelutong dried in different ways.

Treatment.		Resin per cent.
Extracted wet	...	79.4
Dried at 100°C under reduced pressure..		79.2
Dried at 100°C in a current of air	...	79.8

As drying has no appreciable affect on the resin content, the following tables giving the resin content of jelutong dried in different ways are comparable.

TABLE V.

Resin content of samples of jelutong which remained undeteriorated after 6 months.

Sample No.		Resin per cent.
1.	...	79.1
4.	...	78.4
5.	...	76.5
6.	...	79.2

TABLE VI.

Resin content of samples of jelutong which underwent natural deterioration.

Sample No.	Resin per cent on fresh sample.	Resin per cent on deteriorated sample.
2.	80.6	80.5
3.	77.0	82.6
7.	82.0	82.6

These figures show that jelutong normally contains from 76 per cent to 82 per cent of resin. A normal resin content however is no criterion of quality although an abnormally high resin content is indicative of deterioration.

TABLE VII.

Changes in weight and resin content due to prolonged heating at 100°C.

No.	Treatment.	Change in weight per cent.	Resin per cent.
1.	Crepe heated in a current of air for 1 month ...	– 0.1	92.4
2.	Block heated in current of air for 1 month ...	+ 0.35	90.5
2.	Block heated in a current of air for 1 week ...	– 1.7	79.8
3.	Crepe heated in a current of air for 1 week ...	+ 0.75	94.9
3.	Block heated in a current of air for 1 week ...	- 7.8	98.5
3.	Block heated under reduced pressure for 1 week ...	– 4.8	97.6

These figures show that the action of heat on jelutong is to increase its resin content and that it is possible by sufficiently prolonged heating to convert nearly all the caoutchouc fraction into resin.

Moreover, resinification occurs equally whether the sample is heated in a current of air or under reduced pressure. It is inconclusive therefore whether resinification is due to oxidation of the caoutchouc, although the increase in weight which occurs in two cases favours the oxidation hypothesis, In one case a sample when heated in a current of air lost weight for three weeks before beginning to increase. In another case a sample which had gained 0.4 per cent in weight after heating for one month was transferred to a flask with a reflux air condenser. This was heated on the steam bath and yielded an amorphous sublimate and a crystaline sublimate, while drops of an acid liquid condensed in the reflux tube. The change in weight during heating is therefore the resultant of an increase (due probably to oxidation) and a decrease due to the escape of moisture and other volatile constituents: so that resinification of jelutong even if primarily due to oxidation of the caoutchouc to resin is accompanied by complicated secondary reactions. Resinified jelutong is very sticky when hot and very brittle when cold, in which respects it resembles naturally deteriorated jelutong. It was decided that a complete investigation of the oxidation process was too lengthy to be essayed at present. Under these circumstances no analyses of the resin itself were undertaken. It was noted however that the resin of good undried jelutong was white and hard even when hot while that extracted from deteriorated jelutong was viscous when hot and brown in colour. The degree of colour of the resin varied with the extent to which the jelutong had previously been heated. This seems to indicate that --as is the case with *Hevea* rubber—resin resulting from the oxidation of the caoutchouc is different from the resin originally present.

Mould development.—Although moist *Hevea* rubber is highly susceptible to mould growth, jelutong rubber is far less so. Except

for transient slight exterior discolorations, the only cases in which any degree of mould development have been found are:—

1. Crude unpressed coagulum stored in a cool, dark place.

2. Commercial samples of "refined jelutong."

The former case is of negligible commercial importance since the conditions were abnormal. In the latter case however mould growth occúred under normal circumstances, i.e. when a block was cut in half and exposed to the air.

As susceptibility of rubber to mouldiness is considered to be related to protein content, estimations of nitrogen were carried out on several samples and the results tabulated in table VIII.

TABLE VIII.

Proportion of nitrogen and protein in various samples of jelutong (calculated on the dry material)

	Nitrogen per cent.	Equivalent to protein. per cent.
Jelutong latex	0.112	0.70
Fresh wet coagulam	0.084	0.53
" Refined jelutong "	0.112	0.70

These figures show that although the proportion of nitrogen is very small, the bulk of it is associated with the coagulum. Treatment with "obat" causes a small increase in nitrogen content due to addition of ammonia. In order to determine suitable mould preventitives, blocks of "refined jelutong" were prepared with the addition of various antiseptics according to table IX.

TABLE IX.

Proportion of various antiseptics added to "refined jelutong."

No.	Antiseptic added.	Quantity on wet weight of jelutong. per cent.
1	Formalin	0.14
2	Formalin	0.20
3	Phenol	0.04
4	Beta-naphthol	0 04
5	Mixed phenols	0.04
6	Sodium bisulphite	0.04

Each block was cut in half: one half was placed under an electric fan and the other half maintained moist by the daily addition

of water. After one month, samples No. 1, 2 and 3 both wet and dry showed signs of mould while samples No. 4, 5 and 6 were free from mould. The actual exterior of the blocks was far less susceptible to mould than the interior. This was probably due partly to the presence of a very dry skin which formed and partly to removal of soluble food materials by the prolonged immersion in water. In all cases of mouldiness the effects were purely superficial and the interior of the blocks were in no way affected. Samples of mouldy jelutong were examined by the Mycologist who reported on them as follows :—

"Surface discolorations appear on prepared jelutong blocks. "These discolorations are caused by fungi though little pro- "gress is made compared with the rate of progress of fungus "discolorations on ordinary rubber. It would appear that jelu- "tong is not so good a medium for fungus growth as the rubber "from *Hevea brasiliensis*. The commonest discolorations noted "have been black, yellow and red. Only in the first does the "fungus progress to any extent. Two fungi have been found "associated with the black discolorations; one a species of "*Phoma*, which does not appear to be closely associated with the "blackening of the jelutong, the other a *Brachysoperium* type of "fungus which produces short four-celled dark coloured spores; "this fungus seems capable of slowly penetrating the jelutong "blocks. No definite association of a fungus with the yellow or "red spots has been observed. In most discoloured pieces taken "from jelutong blocks, the black discoloration is present along "with either the yellow or red. When small pieces are taken "placed on damp blotting paper in petri-dishes the usual course "is for a profuse development of *Penicillium* and *Eurotium* Spp., "which eventually disappear. The red and yellow spots are still "noticable even after the disappearance of the above mentioned "fungi, but they gradually fade out, and the fungus causing the "black discoloration is the only one to remain. This fungus "appears to be strongly resistant to desiccation and makes "progress in apparently well dried pieces of jelutong".

Summary.

I. Conditions in the F M.S. appear to be favourable for meeting the growing demand for Jelutong.

II. Various methods of coagulation and "refining" are described and commented on.

III. The characteristics and defects of jelutong prepared in various ways are enumerated and dealt with under the headings :—

1. Rate of drying.
2. Resinification.
3. Mould development.

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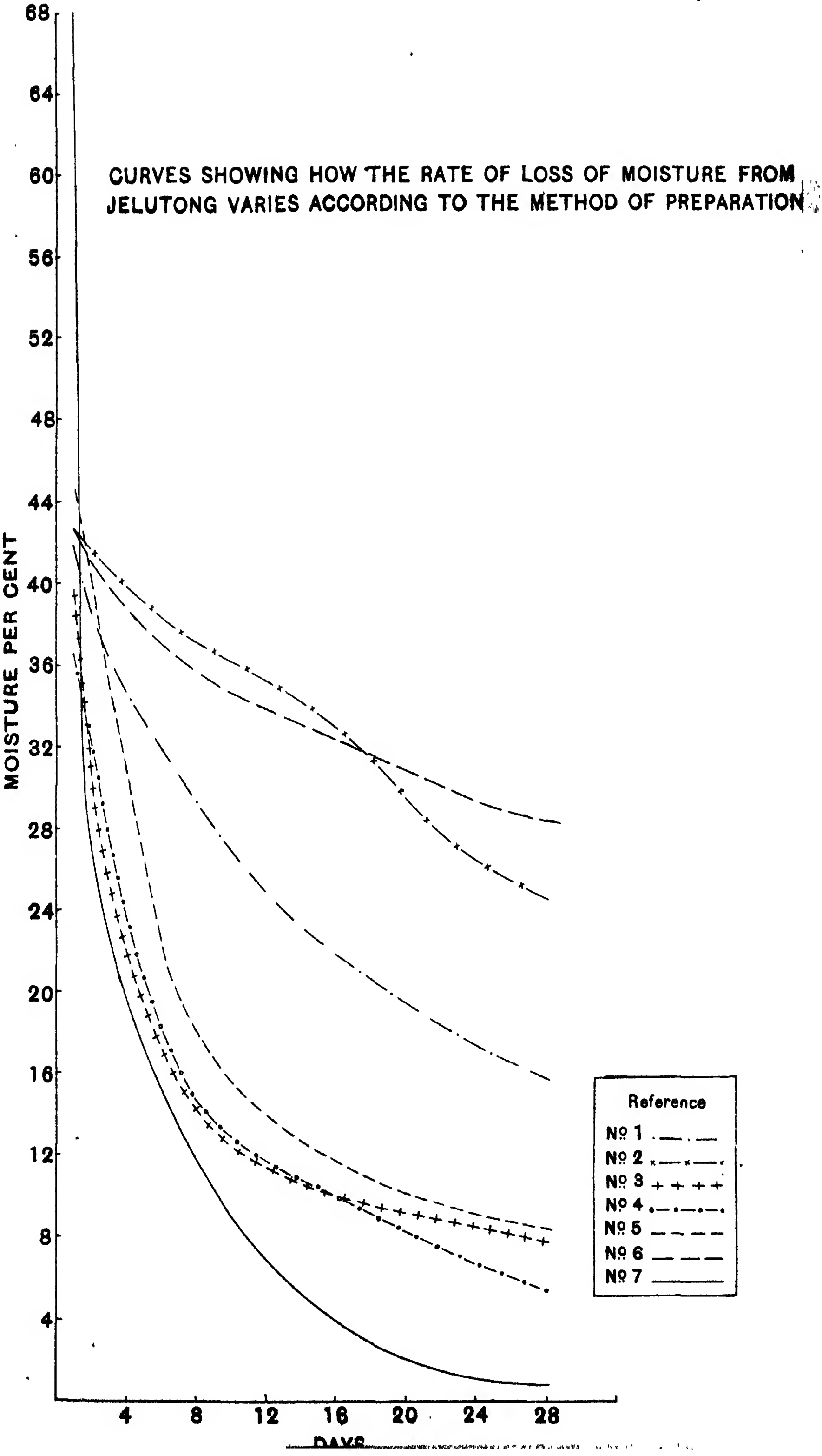
CURVES SHOWING HOW THE RATE OF LOSS OF MOISTURE FROM JELUTONG VARIES ACCORDING TO THE METHOD OF PREPARATION
MOISTURE PER CENT
68
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DAYS
Reference
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Nº 2
Nº 3
Nº 4
Nº 5
Nº 6
Nº 7

TWO NEW APPLICATIONS OF RUBBER.

By B. J. Eaton.

I.—Rubber Stop-Butts.

An interesting and useful application of raw rubber has been discovered by Mr. W. Towgood, late of Kuala Selangor.

This consists in the application of raw rubber as stop-butts for rifle shooting.

This application of rubber has received an enthusiastic reception from the Society of Miniature Rifle Clubs in Great Britain, as the following advertisement in "The Rifleman," the official organ of this Association, will indicate.

"Advantages of crepe Rubber used on Stop-Butts.

(1) Saves cost of target boards.

(2) Prevents composition of butts being disturbed or distributed which usually happens when boards are shot away.

(3) Prevents bullet splashing thus avoiding:—(a) Danger to surroundings. (b) Damage to lamps. (c) Splash holes on targets.

(4) Captures all shots fired into Bullet-catchers.

(5) Saves the lead, which can be sold and thus benefits rifle club funds.

The reason of all the above advantages is that a great number of shots may pass through the rubber without removing any portion thereof and it solidifies immediately. (Note:- -The hole made by the bullet in passing through the sheet of crepe rubber closes up immediately after the bullet passes through. B. J. E.)

Sheets of crepe rubber, measuring 20 inches by 13 inches by $\frac{1}{3}$ inch thick, suitable for dividing into two parts for two targets (either 25 or 50 yards match cards) or the complete piece may be used for 100 yard match cards, are advertised by the Society in "The Rifleman."

The following is an abstract of articles on the subject which have appeared in "The Rifleman" November, 1923 Volume XX No. 161, December, 1924, Volume XX No. 162 and February, 1924 Volume XX No. 164.

Tests carried out have proved so satisfactory that it is considered that the material will be a prime factor in the construction of stop-butts and will minimise the danger of bullet splinters.

(Note.:—The usual protection for 0.22 bullets at short ranges is a ¼ inch steel plate fixed at an angle of 45°, with the centre opposite the centre of the target to deflect the bullets downwards into a trough lined with stout sheet iron filled with saw dust.)

The stop butts proposed are as follows :—The stop butt box is 12 inches deep 16 inches wide and 17 inches long. The front of the box, to which the target is attached, consists of a piece of the rubber sheet described. The box is divided vertically into two parts by means of a wooden partition to which a similar sheet of rubber is attached. The partition is placed at 10 inches from the front. The distance between the partition and the rear of the box is 6 inches and in the rear space is placed the steel plate at an angle of 45°. The front part of the box between the two rubber sheets is filled with sawdust.

The bullets just penetrate the partition of wood and rubber and drop in the space in front of the steel plate.

Since the holes made by the bullets in the rubber sheets close up immediately, the sawdust is retained in the front part of the box and the clean bullets can be collected periodically from the empty space in the rear portion of the boxes.

In the case of 15 and 20 yard ranges, the front part of the box must be larger, to contain an extra thickness of sawdust, and for 50 and 100 yard ranges may be smaller.

The box is placed at the necessary height on a stand in front of the stop-butt or on brackets attached to the butts.

The size given above (17 inches in length, 16 inches width, 12 inches depth) is suitable for one or two targets. In the case of two or more targets a continuous box, on the same principle, may be cheaper. For outdoor ranges, the tops of the boxes can be covered with a loose sheet of iron to keep out rain.

The writer, through the courtesy of Mr. Towgood, has had the opportunity of seeing a piece of rubber used as a target-board for six months at the Wimbledon Park Rifle Club. Several thousand shots had been fired through the cardboard targets backed with this piece of crepe rubber and the rubber only shows dark spots at the places penetrated. Mr. Towgood obtained this piece of rubber for exhibition on the R. G. A. Stall in the Malaya Pavilion at the British Empire Exhibition.

The most important application is undoubtedly the lining of boxes used as stop-butts. Holes can be cut in the wooden boxes or most of the front and back of the boxes can be cut away. If these

rubber lined boxes are filled with sand, for stopping the bullets, the constant renewal of the boxes is avoided and the sand has not to be continually replaced in new wooden boxes which are splintered rapidly by the bullets. The application is recommended to the attention of our Rifle Clubs in Malaya.

Blue print copies of bullet catchers can be obtained from the Secretary, Society of Miniature Rifle Clubs, Strand, London at 1/-.

II.—FIBROK.

A FIBROUS RUBBER PRODUCT FOR FOOTWEAR.

One of the most useful products exhibited in the Agricultural Section of the Malayan Pavilion at the British Empire Exhibition was Fibrok, a fabric composed of a fibrous material impregnated with latex and used for welting, insoling and middling soles of boots and shoes

The application of this material should increase and encourage the use of the crepe sole, which has already gained considerable popularity in Great Britain.

As is well known, the crepe sole cannot be attached easily to the leather insole or welt of footwear, while if stitched to the leather, the stitches are liable to cut through the crepe sole. The usual method of attachment at present adopted is to stitch a thin layer of smooth crepe to the leather insole and then to attach by solution, a separate piece of crepe, which is rough or corrugated on one surface and smooth on the other side, to the smooth layer of crepe which is stitched to the leather.

In the application of Fibrok, this product can be stitched securely to the leather insole and a crepe sole can then be attached securely, by suitable solutions, to the Fibrok, which forms the "middle" sole of the boot or shoe. The product can also be used instead of leather to form the insole of footwear.

Methods of attachment:—Three solutions, the exact composition of which is not known, but which appear to consist of emulsions made from latex preserved with ammonia and benzene or other suitable rubber solvents, are prepared by Fibrok Products Limited.

For direct adhesion of Fibrok and canvas, for canvas footwear, two solutions (A and C) are employed, solution A being applied to the canvas and solution C to the Fibrok. The treated surfaces are then pressed, rolled or hammered together.

For adhesion between Fibrok and leather the leather is damped and combed with a wire brush and then coated with solution C and the two materials rolled and hammered together.

For adhesion between Fibrok and crepe or between two layers of Fibrok or two layers of crepe, the surfaces are coated with Fibrok C. and then pressed, rolled or hammered together.

Boots and shoes in which Fibrok was used, made by a number of manufacturers, were exhibited in the Malaya Pavilion and attracted considerable attention.

Sheets of Fibrok material in white, brown or grey colours, measuring 64 inches × 26 inches approximately, are prepared by the firm. Samples and further particulars of the product and solutions can be obtained from Fibrok Products Limited. 10 Fenchurch Avenue, London, E.C.-3.

During a visit to the Leather Trades' Exhibition in London the writer also found that a somewhat similar material known as Bateman's Fibrous Crepe was being exhibited by Bateman's Factory, West Harrow, Middlesex.

It was not possible to judge the respective merits of the two products.

The latter firm also stock crepe sole edge stains, black, white and brown, for colouring the edges of crepe soles, in order to match the colour of the uppers. The objection to the manufacture on the estate of coloured crepes for attachment to uppers of similar colour is that inferior crepes may be used, since the application of dyes or colouring matters is liable to obscure defects in the raw rubber. The production of stains to colour the edges, after the crepe soles are attached to the footwear, meets this objection and also supplies the demands of buyers who do not like the natural colour of the crepe sole, when attached to brown or black uppers.

REPORT ON THE WEEKLY FAIRS IN KRIAN.

By Mohamed Noor.

In certain villages in Krian and in Larut Districts a fair is held once a week, mainly for the sale of produce, grown or obtained locally, among the inhabitants of the villages. A few travelling salesmen or hawkers visit each fair in turn bringing cloth, or agricultural implements and materials proper to the season.

The following report by the Acting Agricultural Inspector Perak North, Inche Mohd. Noor, gives interesting details of these fairs and shows that they successfully serve a useful purpose in supplying local needs and providing a local market for all kinds of local produce brought to the market in comparatively small quantities and sold there by the producers themselves. It is hoped that the existence of these local markets will lead to an increased production of food stuffs and fruit around the villages where they are held. For this reason especially it is hoped that similar fairs can be started in villages in most other parts of the country. F.W.S]

Weekly fairs in Krian have, I understand, been in existence in places for several years. On enquiry the present District Officer informed me that they were started long before he came to Krian; those at Simpang Tiga (Kuala Kurau), Gunong Semangol and Titi Serong were started in 1919 ? or 1920.

At present a weekly fair is held at:

(1)	Sungei Gedong	...	on Sunday
(2)	Bukit Merah	...	Monday
(3)	Changkat Lobak, Gunong Semangol and Simpang Tiga (K. Kurau)	...	Tuesday
(4)	Jalan Bahru & Simpang Ampat (Selinsing)	...	Wednesday
(5)	Mesjid Tinggi and Titi Serong	...	Thursday
(6)	Alor Pongsu	...	Saturday.

There is no fair on Friday. Of the ten villages mentioned above, I was only able to visit Sungei Gedong, Bukit Merah and Alor Pongsu on December 23rd, 24th and 25th, 1925.

Each fair generally begins at about six or seven o'clock in the morning and finishes just before or about noon.

There are no stalls or temporary sheds erected for this purpose, all goods being spread out upon ordinary mats, gunny bags and newspapers by the side of the public road or on vacant land close to the village. Kampong people of both sexes are to be seen coming in from

various directions, each carrying a basket or two of whatever goods he or she has for sale.

On arrival the arrangement of articles for sale commences. At the same time the cloth-dealers as well as the toy-sellers are busy with their heavy bundles of cloth and of playthings. Very soon the place is filled with people of various ages and business then begins. Almost every one makes his or her purchases. Between 10 and 12 o'clock the crowd gradually disperses, thus ends the fair.

Movers to the next fair are mostly the cloth-dealers, toy-sellers, book and medicine sellers and the Chinese vegetable sellers.

The following are the principal articles displayed for sale :--

(i) Under the heading of agricultural crops, no cereals, such as padi, rice, pulut rice and maize were seen in any of the fairs I recently visited, the main reason being, I think, that the people store only sufficient padi for their own consumption, the surplus being sold to millers during harvest. Whether it is on sale or not after the next padi harvest remains to be seen. Raw maize is not at present in the market, but a small quantity of it in the form of cake was seen at Sungei Gedong and Alor Pongsu.

(ii) A fair amount of vegetables, such as carrots, yams, eggfruit (brinjals), sweet and Bengal potatoes, cucumber and ladies' fingers are always to be found and are sold by Chinese, the villagers usually bring out chillies and cow-peas (*Vigna catjang*), or a few " mentimun bendang." [1]

No vegetable from the jungle are brought to any of the fairs.

(iii) I did not see any fruits other than a few common varieties of banana or plantain, jack-fruits (*Artocarpus Polyphemia*) and durians. The last two were brought from Larut District by Malays because better prices were expected in Krian

Other local fruits are not in season.

(iv) Coming to the crops of economic importance one can readily get tapioca, coconuts, sireh and split betel nut, Pinang Blah, sold by Banjarese and Javanese women. *Zalacca Conferta*, Assam Kelubi, and *Garcinia atroviridis*, Assam Gelugor, can also be had occasionally.

(v) Java tobacco, " Roko" made of Nipah shoots, all sorts of cigarettes and cigars and matches are sold by Malays and Chinese who come from Bagan Serai and Kuala Kurau.

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1. A kind of pumpkin grown on the banks dividing the rice fields.

(vi) Under the fish and poultry section, a fair amount of fresh and salted river or bendang[2] fish was quickly sold by Banjarese. Salt-fish from Bagan Serai or Kuala Kurau is always brought and sold by Chinese at a reasonable price. For unknown reasons domestic fowls were not in evidence, and, I understand, are not usually brought to the market. Hen and duck eggs can be obtained every week. A fairly large number of ducklings were easily disposed of at Alor Pongsu.

(vii) Spices and oils —all kinds of spices can be obtained at any of the fairs

It is regrettable to see that no coconut oil nor soap is on sale.

Vinegar extracted from the Nipah palm can be procured at a reasonable price at the Sunday fair either in Krian at Sungei Gedong, or in Larut at Simpang Tiga, Changkat Jering.

(viii) Amongst the food-stalls there stood one or two stalls of Malay books (Kitabs, Korans and Hikayats), and of native-prepared medicines and medicinal plants sold by Malays and people from Penang. The business is not very flourishing owing, I am told, to the supply of free medicines to the villagers by the Government once in two weeks.

(ix) Only in exceptional cases are mats and dish covers, Tudong Saji, to be found on sale, but. if required, they can be bought at Sungei Gedong and Alor Pongsu at a fair price.

"Belachan",[3] the Malayan cheese, can be found everywhere in quantity. It is made at Kuala Kurau and is brought to the fair and sold by the Malays of that village.

(x) At every fair there are many cloth-dealers who take up their stand all in a group, each being separated from his neighbour by the beautifully coloured sarong batak[4] that are hung for sale on bamboos or sticks supported by four small wooden posts, with a "kajang"[5] forming the roof. The trade is mostly run by Punjabese who undoubtedly make a fair profit. Different kinds and qualities of cloth that look very attractive at their price are nicely spread out upon the mat. The attention of the passers-by is soon attracted by the various patterns and

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2. Bendang = rice field.

3. Belachan = a paste of prawns and small fish used as a relish for curry.

4. Sarong Batak = Cloth for Malay skirts made by the Batak tribe in Sumatra.

5. Kajang = a waterproof matting made of leaves.

colours of the cloth and by the honeyed words of the tradesmen.

Adjoining these there are a few toy-stalls also run by Punjabese. A large quantity of assorted cheap toys and life-like dolls are offered for sale. The latter are anxiously waiting to be acquired by the passing girls whose repeated cries and pleading usually cause their fathers and mothers to purchase the dolls.

(xi) In another corner usually at the end of the fair Banjarese as well as Javanese women are busily selling all sorts and shapes of cakes and of sweets either prepared at home quite early in the morning, or made on the spot. People, old and young, are invited to partake of this "kueh" in return for a few cents when the purchaser has satisfied his hunger.

Judging from what I have seen at the three places visited I am perfectly certain that weekly fairs in Krian have been a success. Those at Changkat Jering and Batu Kurau also show improvement. It is hoped that each and every district in the F.M.S. will have similar fairs.

The most crowded and successful fair is that at Sungei Gedong the next being at Alor Pongsu.

It is a pity that the people of all the villages at which fairs are held do not attempt to grow vegetables and other food-stuffs regularly in their kampongs, as the Chinese always do. Things can be remedied if every encouragement is given both by the Agricultural Department and the District Officers. I was able to talk on this matter with only one Penghulu in Krian who seemed to agree to what I said, and who told me that he is trying his utmost to make the fair in his mukim more successful than it is at present.

The prices of all the goods sold are fair. It is certainly a dull day for the village shop-keepers, as their usual customers are not anxious to visit them. Things are only bought in the shops if not obtainable in the fair.

Received for publication 8th April 1924.

LIST OF ECONOMIC PLANTS, CULTIVATED AT THE EXPERIMENTAL PLANTATION, SERDANG, SELANGOR, 1925.*

By J. N. Milsum.

Ag Agriculturist, F.M.S. & S.S.

THE object of this article is to provide in tabular form a list of the plants established on the 1st January, 1925 at the Experimental Plantation, Serdang. It is considered that it will be of assistance to visitors to the Plantation, who will thus be able to retain a permanent record of the various plants seen. The list will also be useful for general reference.

The scientific names are those adopted in the 'Index Kewensis.' The majority of the Malay names are taken from the list compiled by Ridley and Curtis, published in the journal of the Straits Branch, Royal Asiatic Society, July 1902.

I.—Food Crops.

Latin Name.	Natural Order.	English Name.	Malay Name.
Arenga saccharifera -	Palmae	Sugar Palm	Kabong
Cajanus indicus -	Leguminosae	Pigeon Pea	Kachang Kayu
Coix Lacryma-jobi -	Gramineae	Job's Tears	Jelai Batu
Dioscorea alata -	Dioscoreaceae	Greater Yam	Ubi Nasi, U. Merah, U. junjong
,, esculenta -	,,	Lesser Yam	Kemili or Kombili
Eleusine coracana -	Gramineae	Ragi	Sambau
Glycine hispida -	Leguminosae	Soya Bean	Kachang Japun
Ipomoea Batatas -	Convolvulaceae	Sweet Potato	Ubi Keledek
Manihot utilissima -	Euphorbiaceae	Tapioca	Ubi Kayu
Maranta arundinacea -	Marantaceae	Arrowroot	
Metroxylon Sagu -	Palmae	Sago	Rembia
Oryza sativa -	Gramineae	Rice	Padi
Pennisetum typhoideum -	,,	Bulrush Millet	
Phaseolus lunatus -	Leguminosae	Lima Bean	Kachang China
Saccharum officinarum -	Gramineae	Sugar Cane	Tebu
Sorghum vulgare -	,,	Sorghum	Betari
Vigna Catjang -	Leguminosae	Cow Pea	Kachang Panjang
Voandzeia subterranea -	,,	Bambarra Ground Nut	,, Manila
Zea Mays -	Gramineae	Maize	Jagong

* Reprinted as Circular No. 1/25.

II.—Fruits.

Latin Name.	Natural Order.	English Name.	Malay Name.
Ananas sativus -	Bromeliaceae	Pineapple	Nanas
Bertholletia excelsa -	Myrtaceae	Brazil Nut	
Bouea macrophylla -	Anacardiaceae	...	Kundangan
Canarium commune -	Burseraceae	Java Almond	Kenari
,, Kadondon -	,,	...	Kedondong Matahari.
,, ovatum -	,,	Pili Nut	
Carica Papaya -	Passifloreae	Papaya	Betek
Chrysobalanus icaco -	Rosaceae	Coco Plum	
Citrus acida -	Rutaceae	Lime	Limau Kapas
,, Limonum -	,,	Lemon	,, Chumbol
Cynometra cauliflora -	Leguminosae	Nam-nam	
Diospyros discolor -	Ebenaceae	Butter Fruit	Buah Mentega
			Buah Sakahlat
Eugenia brasiliensis -	Myrtaceae	Brazil Cherry	
Mimusops elengi -	Sapotaceae	...	Bunga Tanjong
Morus indica -	Urticaceae	Indian Mulberry	
Musa spp. -	Scitamineae	Banana	Pisang
Tamarindus indica -	Leguminosae	Tamarind	Asam Jawa
Terminalia Catappa -	Combretaceae	Indian Almond	Ketapang

III.—Beverages.

Latin Name.	Natural Order.	English Name.	Malay Name.
Camellia Thea -	Ternstroemiaceae	Tea	Cha (doun)
Coffea spp. -	Rubiaceae	Coffee	Kopie
Theobroma Cacao -	Sterculiaceae	Cocoa	

IV.—Fixed Oils and Fats.

Latin Name.	Natural Order.	English Name.	Malay Name.
Aleurites Fordii -	Euphorbiaceae	Tung Oil	
,, montana -	,,		
,, triloba -	,,	Candle Nut	Buah Keras
Arachis hypogaea -	Leguminosae	Ground Nut	Kachang Goreng
Bassia latifolia -	Sapotaceae	Ilippai Nut	
Butyrospermum Parkii -	,,	Shea Butter	
Elaeis guineensis -	Palmae	African Oil Palm	
Elateriospermum Tapos -	Euphorbiaceae	...	Prah
Isoptera borneensis -	Dipterocarpeae	Borneo Tallow	Tengkawang
Ricinus communis -	Euphorbiaceae	Castor Oil	Jarak
Sesamum indicum -	Pedaliaceae	Gingelly	Lenga

V.—Essential Oils.

Latin Name.	Natural Order.	English Name.	Malay Name.
Acacia farnesiana -	Leguminosae	Cassie	Lasano
Canangium odoratum -	Anonaceae	Cananga	Kenanga
Citrus Aurantium var. Bergamia.	Rutaceae	Bergamot Oil	

V.—Essential Oils.—*contd.*

Latin Name.	Natural Order.	English Name.	Malay Name.
Cymbopogon citratus -	Gramineae	Lemon Grass	Minyak Serai Wangi.
„ Nardus -	„	Citronella Grass	Minyak Serai
„ Martini -	„	Geranium oil Grass Palmarosa oil Grass	
Dryobalanops aromatica -	Dipterocarpaceae	Borneo Camphor	Kapur Barus
Pogostemon Cablin -	Labiatae	Patchouli	
„ Heyneanus -	„	„	Nilam
Vetiveria zizanioides -	Gramineae	Vetiver Grass	Akar Usar-usar

VI.—Fibre Plants.

Abroma augusta -	Sterculiaceae		
Agave sisalana -	Amaryllidaceae	Sisal Hemp	
Boehmeria nivea -	Urticaceae	Ramie Fibre	Ramin
Bromelia argentina -	Bromeliaceae	Caraguata Fibre	
„ Balansae -	„		
„ Magdalenae -	„	Pita Fibre	
Corchorus capsularis -	Tiliaceae	Round-podded Jute	
„ olitorius -	„	Long-podded Jute	
Crotalaria juncea -	Leguminosae	Sunn Hemp	
Eriodendron anfractuosum	Malvaceae	Kapok	Kabu-kabu, Kerkabu.
Furcraea cubensis -	Amaryllidaceae		
„ gigantea -	„	Mauritius Hemp	
Gossypium barbadense -	Malvaceae	Long-staple Cotton	Kapas
„ brasiliense -	„	Kidney Cotton	Kapas
Hibiscus cannabinus -	„	Bimlipatam Jute	
„ Sabdariffa var. altissima.	„	Roselle Fibre	
Musa textilis -	Musaceae	Manila Hemp	Pisang hutan
Sansevieria trifasciata. -	Haemodoraceae	Bowstring Hemp	
„ metallica -	„		

VII.—Drugs.

Chenopodium ambrosioides var. anthelminticum -	Chenopodiaceae	Chenopodium oil plant	
Cola acuminata -	Sterculiaceae	Kola Nut	
Croton Tiglium -	Euphorbiaceae	Croton Oil	Chengkian
Erythroxylon Coca -	Linaceae	Cocaine-Plant	
Hydnocarpus anthelminthicus -	Bixaceae	Chaulmoogra Oil	
Hydnocarpus Wightiana -	„		
Jatropha Curcas -	Euphorbiaceae	Purging Nut	Jarak Blanda
Psychotria Ipecacuanha -	Rubiaceae	Ipecacuanha	
Teraktogenos Kurzii -	Bixaceae	(Burmese) Chalmoogra or Kalaw	

VIII.—Spices.

Latin Name.	Natural Order.	English Name.	Malay Name.
Cinnamomum zeylanicum	Lauraceae	Cinnamon	Kayu Manis
Eugenia caryophyllata	Myrtaceae	Clove	Chengkel
Myristica fragrans	Myristicaceae	Nutmeg	Pala
Piper nigrum	Piperaceae	Pepper	Lada Hitam
Vanilla planifolia	Orchidaceae	Vanilla	

IX.—Dyestuffs & Tanning Materials.

Bixa Orellana	Bixaceae	Annatto	Kesumba
Indigofera Anil	Leguminosae	Indigo	Nila
,, arrecta	,,	Java-Natal Indigo	
Uncaria Gambier	Rubiaceae	Gambier	Gambir

X.—Fodder Grasses.

Andropogon halepensis	Gramineae	Johnston Grass	
,, sorghum sudanensis	,,	Sudan Grass	
Axonopus compressus	,,	Carpet Grass	
Chloris Gayana	,,	Rhodes Grass	
Coelorrachis glandulosa	,,		Terapoh, Tebu Salak
Cynodon Dactylon	,,	Bermuda Grass	
Digitaria didactyla	,,	Australian Blue Couch	
,, eriantha	,,		
Mellinis minutiflora var. mutica	,,	Molasses Grass	
Panicum laevifolium	,,		
,, maximum	,,	Guinea Grass	
,, muticum	,,	Mauritius Grass	
Paspalum dilatatum	,,	Dallis Grass	
Pennisetum purpureum	,,	Napier Grass	
,, ,, var	,,	Merker Grass	
Sorghum versicolor	,,		
Tricholaena rosea	,,	Natal Red-Top Grass	
Urochlea brachyura	,,		
Zoysia pungens	,,		

XI.—Fodder Crops.

Desmodium tortuosum	Leguminosae		
Prosopis juliflora	,,	Algaroba Bean	
Stizolobium Deeringiana	,,	Velvet Bean	Kachang Balanga

XII.—Cover Crops.

Latin Name.	Natural Order.	English Name.	Malay Name.
Calopogonium mucunioides	Leguminosae		
Canavalia ensiformis -	,,	Sword Bean	Kachang Parang
,, turgida -	,,		,, Hantu
Cassia hirsuta -	,,		Sinteng
,, mimosoides -	,,		
,, occidentalis -	,,		Kachang Kota
Centrosema Plumieri -	,,	Butterfly Pea	
,, pubescens -	,,		
Clitoria cajanifolia -	,,		Beluntas Padi
Crotalaria anagyroides -	,,		
,, incana -	,,		
,, maijussai -	,,		
,, striata -	,,		
,, usaramoensis -	,,		
Desmodium gyroides -	,,		
Dolichos biflorus -	,,	Horse Gram	
Leucaena glauca -	,,		Petai Jawa
Mikania scandens -	Compositae		Akar Lupang
Mimosa invisa -	Leguminosae	Giant Mimosa	
Sesbania aculeata -	,,		
,, sericea -	,,		
Tephrosia candida -	,,		
,, Hookeriana var. amoena -	,,		
,, purpurea -	,,		
,, Vogelii -	,,		
Vigna marina -	,,		
,, oligosperma -	,,	Sarawak Bean	

XIII.—Shade Trees.

Adenanthera pavonina -	Leguminosae		Saga besar
Calophyllum inophyllum -	Guttiferae		Penaga Laut
Erythrina indica -	Leguminosae	Dadap	Dedap
Gliricidia maculata -	,,		
Jacaranda ovalifolia -	Bignoniaceae		
Peltophorum ferrugineum -	Leguminosae		
Pithecolobium dulce -	,,	Madras Thorn	
,, Saman -	,,	Rain Tree	

XIV.—Miscellaneous Products.

Areca Catechu -	Palmae	Areca Nut	Pinang
Derris elliptica -	Leguminosae	Tuba Root	Tuba
Dialium laurinum -	,,		Karanji Papan
Entada scandens -	,,		Akar Sintok
Hymenaea Courbaril -	,,	West Indian Gum Tree.	
Nicotiana rustica -	Solanaceae	Tobacco	Temakan
,, Tabacum -	,,	,,	Temakan
Palaquium Gutta -	Sapotaceae	Gutta-percha	Getah Taban Merah
,, obovatum -	,,		,, ,, Puteh
Zingiber officinale -	Scitamineae	Ginger	Haliya

LONDON MARKET PRICE LIST, 4th QUARTER 1924.

Oil Seeds.

Castor (Bombay)	-	£31.15.0 per ton.
Copra (Ceylon)	-	£32. 5.0 „ „
Do. (Straits)	-	£31. 2.6 „ „
Cotton (Egyptian)	-	£13.17.6 „ „
Do. (Bombay)	-	£11.17.6 „ „
Croton		27/6—32/6 per cwt.
Desiccated Coconut (fine)	-	42/6 „ „
Do. Do. (medium)	-	42/6 „ „
Do. Do. (coarse)	-	45/- „ „
Gingelly (Chinese)	-	£29.15.0 per ton.
Groundnuts (Gambia, undecorticated)	-	£20.15.0 „ „
Do. (Chinese, decorticated)	-	£25.10.0 „ „
Linseed (Bombay)	-	£24.10 0 „ „
Do. (Plate)	-	£22. 5.0 „ „
Palm Kernels (West Africa)	-	£22.15.0 „ „

Oils.

Castor (Madras)	-	70/- per cwt.
Do. (Pharmaceutical)	-	80/- „ „
Do. (1st pressing)	-	75/- „ „
Do. (2nd pressing)	-	73/- „ „
Coconut (Cochin)	-	60/ „ „
Do. (Ceylon)	-	47/6 „ „
Cotton seed (Egyptian, crude)	-	48/- „ „
Do. (Bombay)	-	41/- „ „
Groundnut (Oriental, crude)	-	52/- „ „
Do. (English)	-	51/6 „ „
Linseed (Calcutta)	-	44/6 „ „
Do. (Plate)	-	43/6 „ „
Palm (Lagos)	-	£42.10.0 per ton.
Do. (Sumatra)	-	£36. 2.6 „ „
Palm kernel	-	45/- per cwt.

Oil Cakes.

Coconut	-	£12.12.6 per ton.
Cotton (Egyptian seed)	-	£ 8.15—£ 9.2.6 per ton.
Do. (Bombay seed)	-	£ 8.10— „ „ „
Groundnut (decorticated)	-	£13. 5—£13.10 „ „
Linseed	-	£13.12.6 „ „
Palm kernel	-	£ 8.10.0 „ „

Essential Oils.

Cajeput	-	3/2 per lb.
Camphor (Chinese, crude)	.	2/4½ „ „
Do. (Japanese, refined)	-	2/8 —2/9 „ „
Camphor (oil)	-	60/- per cwt.

sential Oils.—*contd.*

Cinnamon (Ceylon leaf)	6/8—7/4 per lb.
Citronella (Ceylon)	3/1 ,, ,,
Do. (Java)	5/8 ,, ,,
Clove	7/3—7/6 ,, ,,
Lemon grass (Cochin)	4/3 ,, ,,
Lime (West Indian, expressed)	10/- ,, ,,
Do. (do. distilled)	6/- ,, ,,
Patchouli (Penang)	14/6—18/- per lb. (according to quality)
Do. (Mysore)	18/- ,, ,,
Vetiver (Bourbon)	50/- ,, ,,

Spices.

Capsicums (East Indian)	40/-—45/- per cwt.
Do. (Nyassaland)	60/-—70/- ,, ,,
Chillies (Zanzibar)	35/-—40/- ,, ,,
Do. (Nyassaland)	50/-—60/- ,, ,,
Do. (Japan)	149/- ,, ,,
Cinnamon (Ceylon)	1/4—1/7 per lb.
Cloves (Zanzibar)	1/-—1/1 ,, ,,
Do. (Penang)	2/6—3/- ,, ,,
Ginger (Japan)	92/- per cwt.
Do. (Jamaica)	140/-—170/- ,, ,,
Mace (Bombay and Penang)	2/6—3/2 per lb.
Nutmegs (Singapore and Penang)	
110's	2/2 ,, ,,
80's	2/5 ,, ,,
64's—57's	2/5—2/6 ,, ,,
Pepper (Singapore, black)	5d. ,, ,,
Do. (do. white)	9d. ,, ,,
Turmeric (Bengal)	80/- per cwt.

Drugs.

Cinchona Bark	According to Analysis.
Cocaine (hydrochloride)	24/- per oz.
Ipecacuanha (Rio)	7/6—8/- per lb.

Natural Dyestuffs and Extracts.

Annatto (seed)	10d.—1/- per lb.
Gambier (block)	70/- per cwt.
Do. (cubes)	120/- ,, ,,

Gums and Resins.

Damar (Singapore)	80/-—150/- per cwt.
Do. (Batavia)	120/-—160/- ,, ,,
Dragon's blood (reeds)	£18—£25 ,, ,,
Do. (lump)	£11—£38 ,, ,,
Guttapercha (genuine)	2/9—6/- per lb.
Do. (Sarawak)	3/-—4/- ,, ,,
Do. (Siak, reboiled)	9d. ,, ,,
Jelutong	£30—£60 per ton.

Fibres.

Cotton (American G.O. to Mid.)	-	12.04d.—13.69d. per lb.
Do. (Egyptian, Sakellaridis, G. F. to fine)	-	25.10d.—27.80d. „ „
Hemp (Manila, "J" grade)	-	£56 per ton.
Do. (Mauritius)	-	£45.10—£48 „ „
Do. (New Zealand)	-	£42.10—£44.10 „ „
Do. (Sisal)	-	£27—£53 „ „
Kapok (Indian)	-	10½d. per lb
Do. (Java)	-	1/1—1/2 „ „

Foodstuffs.

Cocoa (Ceylon, plantation)	-	80/-—115/- per cwt. (in bond)
Coffee (Malay, plantation)	-	100/-—130/- per cwt. (in bond)
Do. (Malay, Liberian)	-	100/-—111/- per cwt. (in bond)
Sago (pearl)	-	28/- per cwt.
Do. (flour)	-	17/6—18/6 „ „
Sugar (Java, white)	-	20/1½ „ „ „ (excluding duty)
Tapioca (Penang, flake)	-	3½d.—4d. per lb.
Do. (Penang, flour)	-	18/-—22/- per cwt.

Chemicals.

Acetic acid (glacial)	-	£68.10 per ton.
Do. (80% comml.)	-	£43. „ „
Acetone	-	£93—£94 „ „
Ammonia (.880)	-	£22 „ „
Calcium acetate (grey)	-	£14 „ „
Citric Acid	-	1/3½ per lb.
Formalin (40% vol.)	-	£49 per ton.
Lime Juice (concentrated)	-	£18.15 per basis.*
Sodium bisulphite (60—62%)	-	£17—£18 per ton.
Sodium sulphite (anhydrous)	-	£27.10 „ „
Wood Creosote (unrefined)	-	2/9 per gallon.

* Basis = 108 gallons, 64 ozs. of Citric Acid per gallon.

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VARIATION IN COCONUTS WITH PARTICULAR REFERENCE TO FRUIT PRODUCTION.

By H. W. Jack.

THE selection of seed nuts is probably of greater importance in the case of coconuts than of any other crop grown on plantation lines when due consideration is given to the length of the profitable life of the palms which under good conditions should certainly exceed fifty years, and yet little real attention is given to the question when land is being opened for coconut cultivation.

The term "selected" as regards seed coconuts is misapplied to a very large extent at present, the methods of selecting them being far from scientific and rarely being based on a thorough examination of the individual tree. The commonest method of selection is that of purchasing seed nuts from a well established estate which is known to produce a fair quantity of copra per acre. This method is tolerably sound in the absence of reliable tree data as long as the trees from which the nuts are divided are growing in soil conditions similar to those existing on the area where it is desired to establish a new plantation, but merely ensures the production of trees of average utility. A vast improvement on this method is that of examining the trees in the field and marking as parents the individual trees which show desirable characters or which closely approximate to an approved type. This method, if thoroughly performed, should result in a more uniform plantation than the more casual method which is usually adopted, though complete uniformity cannot be obtained because trees which appear very much alike, differ not only constitutionally but seedlings from the same parent tree may be found to vary to an extent as yet undetermined, on account of cross-pollination which undoubtedly takes place though by no means to the exclusion of self-pollination as contemporaries maintain elsewhere. There are, in fact, many single coconut palms in Malaya isolated by several miles of jungle on which numerous fruits of all ages can always be seen, in spite of the depredations of monkeys. Instances may be seen in the lowlands on the Jerantut-Kuantan Road, at Jor at an elevation of 2,000 feet and at several other places.

For practical guidance in the matter of selecting parent trees by inspection in the field, the planter could not do better than study the lines indicated by Sampson (1) who investigated this important question very thoroughly, but who maintains that a detailed cropping register of each tree is the ideal. A practical method for establishing a register of this nature is described in the Malayan Agricultural Journal (2), and this paper is based on the results obtained by the maintenance of systematic records extending over four years.

In coconut cultivation, variation is well known to occur in many characters of which some, such as colour, size and shape of fruit are readily apparent, while other characters can only be revealed by careful investigations covering an extended period In the latter category can be included seasonal variation in cropping, variation in root formation, variation in female flower production, and in the production of mature fruits per palm, variation in size and shape of nut, in thickness of meat, in oil content of the meat, in the rate of germination of seed nuts from different palms of the same variety, and in other characters.

A perusal of the annual exports of copra from the Federated Malay States (3) clearly reveals the seasonal vagaries of cropping. For instance, the exports in 1923, which was a bad coconut year climatically, were 824,028 pikuls as against 928,619 pikuls in 1922, despite the increased age of the coconut trees, additional young areas coming into bearing, the fact that the average price in 1923 was over 50 cents. per pikul higher than in 1922, and that the rubber market was still so dull. This represents a variation of over 12%.

Statistics collected from fifteen representative estates scattered over Malaya show an average decrease of over 11% in the yield of copra per acre in 1923 as compared with 1922, thus reflecting fairly closely the loss shown in the exports.

Such variation in cropping at times becomes a matter for concern to shippers of copra who reserve definite space for this product on their ships, and shortages sometimes mean loss unless other merchandise for export is abundant.

It is often claimed that coconut palms are periodic as regards their annual production of fruit but an examination of the figures of yield of ripe fruits per palm as shown in the Appendix disproves this and shows that the variation in yield is due to other causes of which climate, cultural operations and environment are the chief.

For the individual palm, variation in fruit production, under ordinary cultural conditions, must be largely climatic because good

and poor fruiting years for a mixed population argue against the tendency in the individual tree towards periodic fruiting. Annual variation in crops shows that fruiting has been determined by some extraneous circumstances which effect all the trees in a plantation alike, whereas if there was any innate tendency towards periodic fruiting it would be exhibited by different individuals in the same year, and consequently, in a plantation containing many palms, annual uniformity of production would result. This paper shows that uniform annual production is not achieved under normal conditions.

Sampson (1) who made a detailed study of the root systems of palms recorded wide variations in the number of roots formed per palm on palms growing under approximately the same conditions. For instance, an examination of the root systems of 6 palms of the same age, growing in the same field, showed a range of variation in the number of roots per palm from 1,460 to 2,405.

Similarly, variations in female flower production amongst palms of the same variety and age, growing side by side under ostensibly similar conditions, are pointed out by the same author, who traces them directly to physiological causes correlated with climatic changes. For instance, the number of female flowers per spathe on consecutive spathes of a single typical tree covering a two-year period were found to be 13, 12, 19, 14, 17, 27, 30, 17, 16, 15, 18, 17, 10, 9, 14, 18, 26, 14, 15, 14, 18. The single tree variation is still wider when the number of ripe fruits per spathe is considered.

In a mixed population of 102 palms approximately 10 years old, growing on excellent coastal land, the number of spathes, in situ per palm was found to vary from 2 to 18 with an average of 9, all the palms receiving as nearly as possible the same treatment in cultivation and drainage (4).

Within the same variety, even with adjacent trees subject to the same conditions of climate and cultivation and bearing fruits approximately equal in size, enormous variation in the size of the kernel is found, ranging from .4 to .6 of an inch as average limits, though under adverse conditions such as might be found where heavy and exhaustive cover crops like sweet potato or tapioca have been grown continuously, the meat is frequently much thinner, even being reduced to .2 inch or possibly less.

The oil content of the meat has also been found to vary greatly, local limits being from 52 to 80 per cent (5) and though much of this variation may be due to difference in ripeness of the nuts no doubt a fair amount of real variation exists. Preliminary experiments show a variation in the oil content of nuts grown on the same tree of 11 per cent.

There is also a wide variation in the amount of (toddy) obtainable from the treated flower stalks of different palms. Moreover the same palm will show a marked seasonal variation in sap production the flow being stimulated by fine weather, though prolonged drought is liable to retard it.

Rainy cloudy weather greatly retards sap flow. The quality of the sap, that is the amount of sucrose it contains, also varies with the age of the tree and the part of the spathe being tapped. Young palms do not yield such a rich juice as older ones, and the tips of the spathes produce sap which is not so rich as the sap produced by the middle or lower parts of the spathe.

The rate at which seed nuts of approximately equal maturity collected from different trees of the same variety germinate was found to vary greatly, the time taken by each group of 10 nuts from each of six trees to form shoots 1 foot long varying from 2 to 5½ months (6). In this instance, naturally, a certain proportion of the variation was due to differences in ripeness of the nuts despite the fact that the nuts were collected from trees which were systematically picked at regular intervals of 5 weeks for a period of four years by experienced coolies, but such differences could not possibly account for such widely differing rates of germination.

As to the causes of variation, climate, cultural operations and environment play a very great part but the hereditary characteristics of the tree must not be overlooked.

Variations in the shape, size and weight of fruits and of kernels borne by a single tree and which arise as modifications due to varying environmental conditions, particularly climate and cultural operations, may only be transitory and as such, these variations will be found to fluctuate about the " mean" or "mode" for each character provided that observations are maintained for a sufficiently long period, that fair cultivation is maintained and that the trees are not too old. On the other hand, despite environmental factors which vary in degree, each tree will retain its own individuality as long as conditions favour a fair degree of development.

In confirmation of this statement, it has been found, through the systematic records on which these notes are constructed, that in a mixed population of trees such as is found on any coconut estate, good producing trees on the average remain proportionately good yielders from year to year, while poor yielders continue to produce poorly. For instance, the annual fruit production of 15 trees, selected from the records to represent five good producers, five medium producers and

five poor producers, is fairly proportionate from year to year as may be seen from an examination of the following table :—

Row No.	Tree No.	Yield of ripe fruits per annum.				Average for 4 years.
		1920	1921	1922	1923	
1	5	102	117	98	78	99
6	5	98	103	100	113	104
10	3	140	129	91	122	121
11	17	89	105	118	108	105
14	10	135	119	114	91	115
1	7	42	64	63	64	58
2	12	48	67	66	75	64
4	5	60	69	62	64	64
7	4	64	86	51	80	70
8	4	63	78	71	74	72
6	18	16	24	22	22	21
7	15	22	29	37	37	31
10	8	20	23	28	32	26
11	20	14	26	27	22	22
18	21	32	27	24	26	27

Of course, the records do not cover a sufficiently long period to render the figures absolutely reliable but their comparative uniformity would definitely indicate that the ability to fruit, apart from seasonal variation, is an hereditory character.

It may be argued that different trees vary widely in the rate at which they come to maturity and assuming this to be true, that the records were initiated when the trees were too young being just under 10 years old. Against this, however, most planters in Malaya will agree that coconut trees under good average conditions, while they may not have reached their full bearing stage at 10-14 years old, are certainly not very remote from it. In any case this argument in itself is a confirmation of the tree's individuality.

A summary of the records on which this study of variation in fruit production is based is shown in the Appendix. The fruit was collected 39 times, or once every 5 weeks, between 1.6.1920 and 31.5.1924 a period of 4 full years, from a local coconut estate (Jugra Lands and Carey United, Division I) of fair average productive capacity as may be guaged from the following figures of copra production per acre per annum from the field in which the records were compiled (the full year ended in April in each case).

Year.		Pikuls.
1915	...	3.21
1916	...	7.31
1917	...	8.88
1918	...	9.77
1919	..	11.74
1920	...	14.16
1921	...	13.35
1922	...	9.30
1923	...	12.97

A block of 480 trees growing in twenty consecutive rows, each row containing twenty-four trees, was chosen as being fairly representative of the conditions on the estate, and each tree was labelled with its row and tree number.

In June 1920, the average age of the trees was just under 10 years and all the trees were planted 30 x 30 feet apart. The estate is well drained, the block under experiment being surrounded on all sides by a drain four feet deep and six feet wide at the top and intersected by two subsidiary drains four-and-a-half feet wide by three feet deep which divide the block into four equal-sized areas. One subsidiary drain runs between rows 10 and 11 and the second cuts it at right angles between the 12th and 13th trees of each row.

The soil consists of a rather stiff alluvial clay loam somewhat on the heavy side for coconut cultivation, but to all appearances very uniform in texture throughout the block. Primarily, the estate was clean-weeded but midway through the four-year period, a cover crop of Centrosema plumieri was sown and slowly established itself affording a fair cover by the end of the third year. At each 5-weekly picking, experienced coolies cut down all the ripe fruits from each tree and piled them near its base ready for counting and recording which was always carefully done.

The ripe fruits were cut by means of a curved knife attached to the end of a long bamboo, as in the majority of the trees the fruit was borne at an average height of 12 feet.

The rainfall during the 4 years averaged 95.89 inches per annum and with the exception of July, (which was dry, except in 1922,) was fairly uniformly distributed throughout each year.

Though some of the trees are known to have been supplies, with the exception of five very young palms which have not yet commenced to bear fruit and which have been eliminated from the records, all the trees appear approximately to be of the same age. Thus, omitting the five very young trees just mentioned, this study is based on records collected from a typical population of 475 palms of approximately the same age, growing under apparently uniform conditions.

Variation in Number of Ripe Fruits Per Picking Per Palm.

The table below indicates the classes and frequencies tabulated from Column 9 of the Appendix—the average number of nuts per picking per palm over the entire period of four years.

Class.	Frequency.	Product —C x F.
1	10	10
2	28	56
3	35	105
4	51	216
5	91	455
6	79	474
7	76	532
8	49	392
9	36	324
10	9	90
11	6	66
12	2	24
	N = 175	2,744

$$\text{Mean} = \frac{2,744}{175} = 5.776 \text{ or say 6 fruits.}$$

The calculation shows a mean production per picking per palm of six fruits and a range of variation of from 1 to 12 fruits. Though pickings occurred every five weeks, in some cases the collection involved more than a single spathe per picking, but probably in 80% of the pickings, judging by inspection (no definite record was kept), fruits were only cut from a single spathe at each picking. The greatest number of fruits collected at any single picking was 30 from Tree No. 5 of Row No. 6., which gave an average per picking over the 4 years of 11 fruits. The highest average number of fruits collected per picking was 12 from two trees—Tree No. 3 of Row No. 10 averaging 12.1 and Tree No. 10 of Row No. 14 averaging 11.8 (say 12) fruits. The number of occasions when a single tree yielded no fruit per picking was 868 or 3.8% of the total number of counts (22,425 counts). Of this number 24 palms which produced 10 or less than 10 fruits per palm in the first year of the records account for 191 or 22% of the occasions. Eighteen of these twenty-four palms on examination were found to possess a close habit of branching, the fronds never expanding but maintaining a more or less upright position though they enjoyed their fair share of sunlight, were not overtopped by neighbouring palms and five of them were favourably situated beside drains. This upward branching habit is apparently distinctly correlated with poor yielding ability in coconuts for none of the eighteen palms displaying this habit produced a crop per annum in

any year under consideration which could be classed as better than poor, with the exception of palm No. 2 of row No. 3 which produced 60 nuts in 1923 and of palm No. 17 of Row No. 9 which produced 78 nuts in 1922, though it only averaged 37 nuts per annum over the 4 years. The high yield of this tree in 1922 was probably due to wound stimulation at the base of the trunk for it has been found that wounding at the collar stimulates fruit production on poor trees and this particular tree was noticeably wounded in that region in 1921. Of the other six palms, one was deformed and one showed an inherent tendency to nut-fall as, though it produced plenty of female flowers and young fruits were always apparent, a very large percentage of the fruits always dropped before maturity or before they could be used for copra production. Four palms were badly shaded and over-topped.

The following table shows the yields yer annum of the twenty-four palms to which reference has been made, together with notes of habit or other cause of poor yield. The first six trees in the table were favourably situated beside drains.

Row No.	Tree No.	No. of times no fruits were obtained.	Yield of fruits in 1920.	Average yield per annum over 4 years.	Notes on Habits, &c.
1	13	4	3	20	Nut-fall
10	1	3	3	17	Up-branching
10	14	4	1	18	Over-shaded
10	20	11	9	18	"
11	5	8	7	20	"
20	1	6	10	29	Up branching
2	8	3	10	22	"
2	5	3	7	20	"
2	11	5	8	13	"
3	2	2	9	36	"
3	9	8	9	17	"
3	11	11	10	13	"
3	16	8	0	20	"
4	23	22	1	5	Deformed
5	15	16	4	8	Up-branching
5	19	14	0	7	"
6	15	16	1	6	"
6	16	2	6	27	"
8	24	13	0	6	"
9	16	3	6	26	Bent & shaded
9	17	2	8	37	Up-branching
13	14	3	8	24	"
14	4	16	4	13	"
18	16	13	4	9	"
24 trees		191	—	431	—

Mean yield per annum per palm $= \frac{431}{24} = 17.96$ – say 18 fruits.

Variation in Rate of Reaching Maturity.

The following table shows the mean yield of ripe fruits per palm per annum for the entire population of 475 palms contrasted with the actual production obtained from a number of individual palms from the same population.

Mean of 475 palms.		1920	1921	1922	1923
		42	65	59	60
Actual Yield.					
Row No.	Tree No.				
3	2	9	31	42	77
5	6	42	82	89	92
7	8	27	71	59	46
9	16	6	28	34	37
13	14	8	26	29	31
14	5	14	34	35	36
15	9	18	48	49	48
17	17	17	109	91	89
18	3	16	31	13	16
19	6	13	23	36	39
20	20	20	49	51	18

This table show that in 1920 some of the palms included in the entire population had not yet reached their normal full bearing stage under the conditions existing on the area, whereas the majority of the palms had, thus proving that individul palms vary in the age at which they reach maturity although field observations reveal no differences in growth. On flat alluvial land in this country, it is commonly noticed that young palms, usually about 10 years old, which have been yielding fairly well for 2-3 years, sustain a setback and produce poorly for 1-2 years before again yielding good crops. This habit is possibly an environmental effect resulting from a high water table which probably arrests the development of the natural root system temporally, causing a shock which retards growth for a time. The habit is, however. also recorded on estates which maintain a fairly low water table (four feet or more) so that it may be merely a growth character, marking the period, after which palms may be said to be mature.

Variation in "Copra" Per Nut.

Experiments are in operation to trace the variation in the amount of copra produced per nut from nuts on the same palm and the variation of copra per nut from different palms, but the number of records yet obtained is insufficient to allow of forming definite conclusions. The variations for seventeen trees have been recorded,

however, and will indicate the tendency towards variation and its range. The amount of copra per nut per palm has been determined by weighing the copra obtained from each individual nut, using only ripe nuts, showing no germination "apple" and not less than 12 nuts to represent each palm. The amount of moisture in the copra of each nut was also determined, and averaged 8 per cent. The variation in the amount of copra per nut from palm No. 4, (to give an example,) using 15 nuts, was found to range from 234 to 275 grammes, the average being 255 grammes—a variation which might reasonably be due to slight differences in the maturity of the individual nuts. Comparing the average weight of copra per nut (average of 12 nuts) from 17 different palms, a range of variation of from 211 to 270 grammes was recorded. This range is sufficient to indicate that the amount of copra per nut varies with different palms. It also discloses the great economic possibilities of selecting the most productive palms as seed producers for future plantings.

Variation in Fruit Production Per Palm.

The following frequency tables show the range of variation in fruit production per palm, the average production per palm for the entire population and the coefficient of variability of population, in each year.

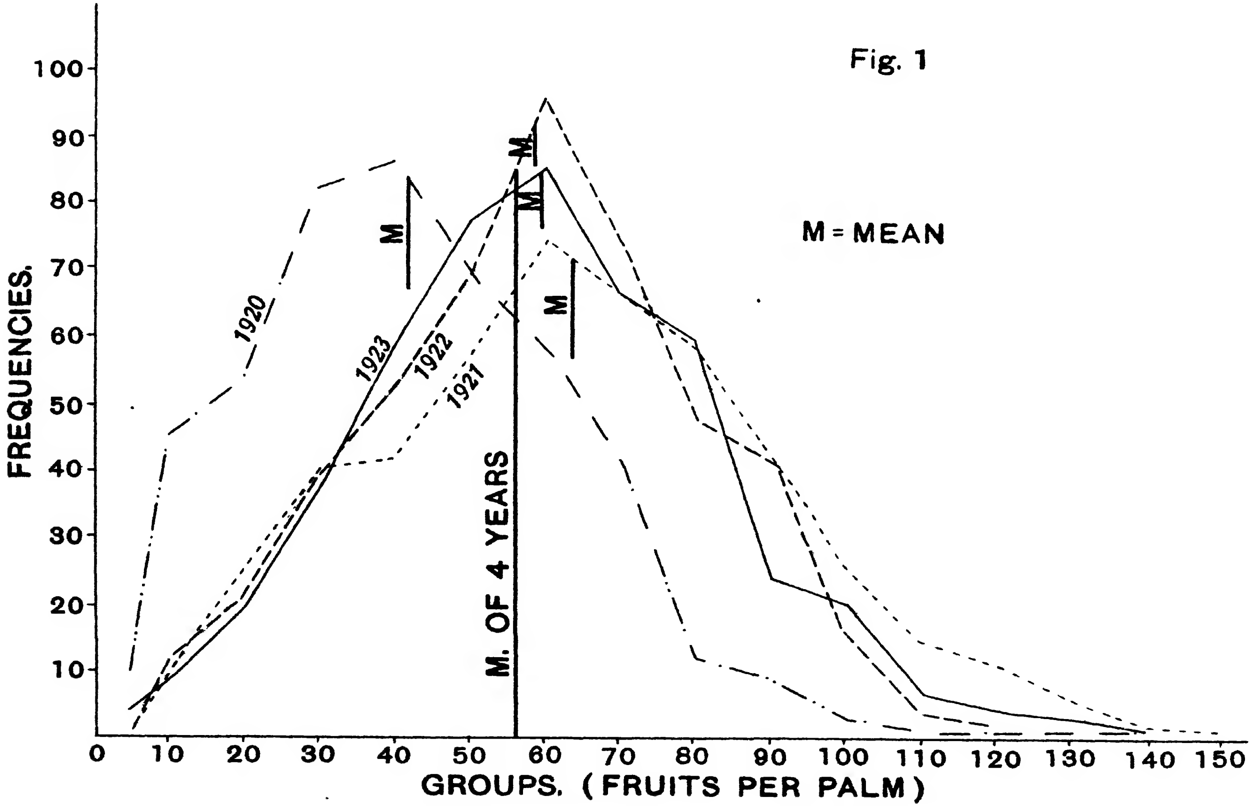

Fig. 1

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Frequency Table 1920.

Group.	F.	F × G.	d	d^2	Fd^2.
5	12	60	37	1,369	16,428
10	45	450	32	1,024	46,080
20	54	1,080	22	484	26,136
30	82	2,460	12	144	11,808
40	86	3,440	2	4	344
50	69	3,450	8	64	4,416
60	58	3,480	18	324	18,792
70	42	2,940	28	784	32,928
80	12	960	38	1,444	17,328
90	9	810	48	2,304	20,736
100	3	300	58	3,364	10,092
110	1	110	68	4,624	4,624
120	0	0	—	-	—
130	1	130	88	7,744	7,744
140	1	140	98	9,604	9,604
N = 475		FG = 19,810			fd^2 = 227,060

$$M = \frac{19{,}810}{475} = 41.7 \text{ say } 42.$$

$$\text{Standard Deviation} = \sqrt{\frac{fd^2}{N}} = \sqrt{\frac{227{,}060}{475}}$$

$$= \sqrt{478.002}$$

$$= 21.863 \text{ fruits.}$$

$$\text{Coefficient of Variability} = \frac{\text{S D.} \times 100}{M} = \frac{21.863 \times 100}{42} = 52.055$$

Frequency Table 1921.

Group.	F	F × G.	d.	d^2	Fd^2.
5	1	5	59	4,481	3,481
10	10	100	54	2,916	29,160
20	25	500	44	1,636	48,400
30	40	1,200	34	1,156	46,240
40	42	1,680	24	576	24,192
50	57	2,850	14	196	11,172
60	74	4,440	4	16	1,184
70	66	4,620	6	36	2,376
80	58	4,640	16	256	14,848
90	42	3,780	26	676	28,392
100	25	2,500	36	1,296	32,400
110	15	1,650	46	2,116	31,740
120	11	1,320	56	3,136	34,496
130	6	780	66	4,356	26,136
140	2	280	76	5,776	11,552
150	1	150	86	7,396	7,396
N = 475		30,495		fd^2 = 353,165	
$M = \frac{30,495}{475} = 64.2$ say 64.					

$$\text{Standard Deviation} = \sqrt{\frac{353,165}{475}}$$

$$= \sqrt{743.5}$$

$$= 27.27 \text{ fruits}$$

$$\text{Coefficient of Variability} = \frac{27.27 \times 100}{64} = 42.609$$

Frequency Table 1922.

Group.	F.	G. × F.	d.	d^2.	Fd^2.
5	1	5	54	2,916	2,916
10	12	120	49	2,401	28,812
20	21	420	38	1,444	30,324
30	39	1,170	29	841	32,791
40	53	2,120	19	361	19,133
50	69	3,450	9	81	5,589
60	95	5,700	1	1	95
70	74	5,180	11	121	8,954
80	48	3,840	21	441	21,168
90	41	3,690	31	961	39,401
100	16	1,600	41	1,681	26,896
110	4	440	51	2,601	10,404
120	2	240	61	3,721	7,442
N = 175		FG = 27,975		fd^2 = 233,925	

$$M = \frac{27,975}{175} = 58.8 \text{ say } 59.$$

Standard Deviation $= \sqrt{\frac{233,925}{175}}$

$= \sqrt{492.474}$

$=$ 22.19 fruits

Coefficient of Variability $= \frac{22.19 \times 100}{59} = 37.610$

Frequency Table 1923.

Group.	F.	F. × G.	d.	d^2.	Fd^2.
5	4	20	54	2,916	11,664
10	9	90	49	2,401	21,609
20	20	400	39	1,521	30,420
30	37	1,110	29	841	31,117
40	59	2,360	19	361	21.299
50	77	3,850	9	81	6,237
60	85	5,100	1	1	85
70	66	4,620	11	121	7,986
80	59	4,720	21	441	26,019
90	24	2,160	31	961	23,064
100	20	2,000	41	1,681	33,620
110	7	770	51	2,601	18,207
120	4	480	61	3,721	14,884
130	3	390	71	5,041	15,123
140	1	140	81	6,561	6,561
N = 475		FG = 28,210		fd^2 = 267,895	
$M = \frac{28,210}{475} = 59.29$ say 59.					

$$\text{Standard Deviation} = \sqrt{\frac{267,895}{475}}$$

$$= \sqrt{563.989}$$

$$= 23.75 \text{ fruits.}$$

$$\text{Co-efficient of Variability} = \frac{23.75 \times 100}{59} \quad 40.254$$

Frequency Table, Average of 4 years.

This table shows the group frequencies of the average production per palm per annum over the entire four year period.

Group.	F.	F. × G.	d.	d^2.	$F.d^2$.
5	1	5	51	2,601	2,601
10	10	100	46	2,116	21,160
20	27	540	36	1,296	34,992
30	39	1,170	26	676	26,364
40	63	2,520	16	256	16,128
50	98	4,900	6	36	3,528
60	74	4,440	4	16	1,184
70	74	5,180	14	196	14,504
80	45	3,600	24	576	25,920
90	32	2,880	34	1,156	36,992
100	7	700	44	1,936	13,552
110	4	440	54	2,916	11,664
120	1	120	64	4,096	4,096
N = 475		ΣFG=26,595		Σ F.d² = 212,685	

$$M = \frac{26,595}{475} = 55.99 \text{ say } 56.$$

$$\text{Standard Deviation} = \sqrt{\frac{\Sigma.F.d^2.}{N.}}$$

$$= \sqrt{\frac{212,685}{475}}$$

$$= \sqrt{447.75}$$

$$= 21.16$$

$$\text{Co-efficient of Variability} = \frac{S.D. \times 100}{M} = \frac{21.16 \times 100}{56} = 37.79.$$

The above tables are summarised below and graphically represented in Fig. I. in which the general uniformity of the frequency curves in each year is apparent.

SUMMARY.

1920 Coeff. of variability – 52.055	Mean yield per palm – 42
1921 ,, ,, – 42 609	,, ,, – 64
1922 ,, ,, – 37.610	,, ,, – 59
1923 ,, ,, – 40.254	,, ,, – 59
Average ,, ,, – 37.79	,, ,, – 56 (4 yrs.)

The Summary and the curves show that 1920 was the poorest yielding year under observation, the average yield per palm from the whole population being only 42 fruits.

This low mean yield is, however, partly accounted for by the fact that approximately 25 per cent (by inspection of records) of the population of palms had not yet entered their period of full maturity, as shown by the figures of annual yield compared with average yield per palm of the population during the year. The same reason would account for the high coefficient of variability in this year. The year 1921 was by far the best yielding period because it was a good one climatically and all the palms appeared to have reached maturity.

The coefficient of variability was, however, a shade above the average for the entire period, probably due to the fact that exceptionally good season forced fruit production to more than average limits.

The year 1922 was normal for the conditions existing on the experimental area and the coefficient of varibility approximated that of the average of the entire four-year period.

In 1923, despite the increased age of the palms, the average—yield per palm was inappreciably greater than in the previous year: moreover, the coefficient of variability was higher than the average both results apparently being due to the less favourable season as compared with 1922.

A perusal of the last frequency table, which gives the average of four years, shows that, for a mixed population of palms growing under fair average conditions on the flat coastal lands of the Peninsula, any individual palm may be found to vary in fruit production by as much as 37.79 per cent from the mean of the population. The table also shows, assuming thirty five nuts per palms per annum as the lowest rate of economic production, that 77 palms or 16 per

cent are below utility standard. Many planters prefer to reckon forty nuts per palm as the minimum rate of profitable production per annum and at this rate 109 palms or 28 per cent of the population consists of unprofitable individuals which produce only 11.6 per cent of the crop, assuming that half the palms in the "40" group produce 40 or less than 40 nuts. If palms which produce less than forty nuts per annum are regarded as uneconomic, and if better yields cannot be induced by practical methods (improved cultivation, manuring, tapping, etc.,) then such palms had better be destroyed and replaced by palms grown from selected seed.

The chief feature of the frequency curves in Fig. I. is their skewness on the positive side showing that the population contains many palms which produce more fruit than the average. The red curve shows the average for the population over the three years 1921, 1922 & 1923, omitting 1920 when the number of immature palms greatly affected the group frequencies.

Period 1921, 1922, 1923. Mean = 60 nuts.

Group.	Frequency.	Group	Frequency.	Group.	Frequency.
5	2	50	68	100	20
10	10	60	85	110	9
20	22	70	69	120	6
30	39	80	55	130	3
40	51	90	36	140	1

The calculated mean yield for the period 1921, 1922, 1923, is 60 nuts per palm per annum and the red curve shows that 36 palms or approximately 8 per cent of the population yielded crops 50 per cent above the mean for the period. This curve also shows that 14 palms produced 75 per cent more fruits than the average while 6 palms yielded 100 per cent above the average for this three-year period.

The large variability which exists and the wide range of fruit production per palm indicated by the group classes in the frequency tables (5 to 150 nuts) show that the coconut crop offers abundant scope for the selection of heavy yielding palms, provided that the copra derived from the nuts (and its oil content) is combined with the quantity of fruits produced in making selections.

Similar records were maintained for four years on a smaller number of palms in Province Wellesley on Batu Kawan Estate, where coconut growing conditions are better than on Carey Island judging by the larger yields of nuts which the records show. This block of fifty palms shows a mean yield per palm per annum over the four-year period of 98 fruits, one palm having the outstanding average yield of 183 fruits per annum, the nuts being medium to smallish in size and containing good thick copra.

This block, which is planted with palms two years older than those on Carey Island and only contains fifty palms, shows a co-efficient of variability in fruiting over four years of 26 as compared with 37.79 for the larger block on Carey Island.

Practical use is being made of these yield records for a fifty-acre block of alluvial well-drained land has been cleared and planted up with progeny rows from the best yielding palms as shown by the records and from several other selected parents growing under dissimilar conditions.

Each progeny row contains twenty-five palms derived from seed-nuts of the same selected parent palm and there are eighty-four progeny rows.

These progeny rows form the basis for further selection when their fruiting capabilities have been tested and for intensive genetic research.

CONCLUSION.

The existence of variation in several characters of the coconut palm has long been recognised, but definite statistical proof of the degree of variation has been very scant. This paper shows definitely that there is a wide range of variation in fruit production per palm. The disposition of the palms from which the records were collected would indicate that the variation was not due to varying soil conditions, for good and poor producing palms stand side by side with great frequency; moreover, alluvial clay soils are notable locally for their general uniformity. Variation in other characters is also indicated.

The frequency curves show the variation in production graphically, and their inspection demonstrates the need for selection in this important branch of tropical agriculture, although results can only be obtained after many years of patient work.

The author is deeply indebted to the General Manager of the Estates for permission to carry out the experiments on which this paper is based, and to Mr. C. F. Mangin, Divisional Manager, for continual assistance with labour and in other ways. He is also grateful to Mr. W. N. Sands, his colleague, for help in collecting the records in the field.

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CAREY ISLAND.

Summary of Coconut Figures.

Appendix.

29.5.20–4.4.20. 18.5.21–24.4.22. 20.6.22–8.5.23. 9.6.23–30.5.24.

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years, per annum.	Average per picking over 4 years to nearest whole number.
1	1	35	51	64	49	199	50	5
	2	64	82	68	75	289	72	7
	3	64	48	88	61	261	65	7
	4	56	83	91	66	296	74	8
	5	102	117	98	78	395	99	10
	6	46	70	88	60	264	66	7
	7	42	64	63	64	233	58	6
	8	71	59	78	78	286	72	7
	9	72	76	89	82	319	80	8
	10	43	57	59	49	208	52	5
	11	23	77	57	50	207	52	5
	12	63	88	93	86	330	83	8
	13	3	23	30	22	78	20	2
	14	54	50	62	25	191	48	5
	15	5	19	24	40	88	22	2
	16	48	78	78	56	260	65	7
	17	41	65	46	58	210	53	5
	18	45	59	68	50	222	56	6
	19	14	23	24	31	92	23	2

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
1	20	67	48	62	53	230	58	6
	21	56	82	89	80	307	77	8
	22	46	63	73	42	224	56	6
	23	90	99	85	76	350	88	9
	24	53	82	68	50	253	63	6
2	1	38	44	62	69	213	53	5
	2	31	50	61	72	214	54	5
	3	10	29	27	20	86	22	2
	4	51	100	97	85	333	83	9
	5	7	22	28	22	79	20	2
	6	62	70	79	63	274	69	7
	7	35	32	45	37	149	37	4
	8	23	37	35	43	138	35	4
	9	77	77	57	68	279	70	7
	10	65	73	62	73	273	68	7
	11	8	16	17	11	52	13	1
	12	48	67	66	75	256	64	7
	13	28	60	54	61	203	51	5
	14	45	63	46	44	198	50	5
	15	30	38	43	44	155	39	4
	16	13	52	34	31	130	33	3
	17	51	82	72	82	287	72	7
	18	15	33	27	17	92	23	2
	19	21	92	59	78	250	63	6

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum	Average per picking over 4 years to nearest whole number.
2	20	46	91	76	72	285	71	7
	21	28	89	69	61	247	62	6
	22	15	79	69	62	225	56	6
	23	65	107	92	76	340	85	9
	24	24	39	46	47	156	39	4
3	1	32	54	52	37	175	44	4
	2	9	31	42	60	142	36	4
	3	29	36	41	26	132	33	3
	4	24	57	50	65	198	50	5
	5	15	14	16	16	61	15	2
	6	35	58	42	61	196	49	5
	7	53	72	58	61	244	61	6
	8	32	45	42	47	166	42	4
	9	9	18	16	24	67	17	2
	10	31	53	57	41	182	46	5
	11	10	18	6	16	50	13	1
	12	41	45	64	60	210	53	5
	13	41	104	87	97	329	82	8
	14	44	61	53	61	219	55	6
	15	13	29	18	22	82	21	2
	16	0	35	25	19	79	20	2
	17	39	45	75	39	198	50	5
	18	10	52	27	39	128	32	3
	19	69	104	78	91	342	86	9

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
3	20	47	42	55	54	198	50	5
	21	37	55	47	59	198	50	5
	22	64	72	73	81	290	73	7
	23	26	74	62	38	200	50	5
	24	33	64	57	51	205	51	5
4	1	17	32	29	31	109	28	3
	2	38	45	55	58	196	49	5
	3	21	51	43	52	167	42	4
	4	23	50	34	51	158	40	4
	5	60	69	62	64	255	64	7
	6	20	41	37	45	143	36	4
	7	45	97	62	54	258	65	7
	8	78	88	65	44	275	69	7
	9	108	94	84	85	371	93	10
	10	28	53	46	44	171	43	4
	11	37	65	53	51	206	52	5
	12	46	54	56	47	203	51	5
	13	16	58	44	63	181	45	5
	14	49	40	56	65	210	53	5
	15	52	66	57	75	250	63	6
	16	17	38	52	34	141	35	4
	17	30	79	60	66	235	59	6
	18	93	89	75	67	324	81	8
	19	37	71	74	79	261	65	7

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
4	20	56	77	72	100	305	76	8
	21	42	64	76	54	236	59	6
	22	56	75	53	72	256	64	7
	23	1	7	3	9	20	5	1
	24	44	60	54	36	194	49	5
5	1	33	73	72	58	236	59	6
	2	21	113	43	61	238	60	6
	3	30	62	58	64	214	54	5
	4	46	71	85	68	270	68	7
	5	22	18	57	10	107	27	3
	6	42	82	89	92	305	76	8
	7	35	30	53	37	155	39	4
	8	54	85	23	84	246	62	6
	9	76	65	67	65	233	58	6
	10	21	64	59	61	205	51	5
	11	54	99	66	109	328	82	8
	12	17	19	25	24	85	21	2
	13	45	65	64	81	235	59	6
	14	32	53	48	56	189	47	5
	15	4	13	13	3	33	8	1
	16	14	16	20	24	74	19	2
	17	26	31	24	82	163	41	4
	18	20	23	29	26	98	25	2
	19	0	12	11	5	28	7	1

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
5	20	92	68	92	100	352	88	9
	21	68	78	89	81	316	79	8
	22	31	59	87	71	248	62	6
	23	71	85	77	80	313	78	8
	24	32	46	33	33	154	39	4
6	1	30	43	54	55	182	46	5
	2	15	48	35	32	130	33	3
	3	52	78	61	59	250	63	6
	4	41	76	71	84	272	68	7
	5	98	103	100	113	414	101	11
	6	29	30	56	54	169	42	4
	7	51	45	65	65	226	57	6
	8	51	66	49	44	210	53	5
	9	43	101	95	89	328	82	8
	10	69	99	81	99	348	87	9
	11	58	72	57	67	251	64	7
	12	19	32	47	31	129	32	3
	13	41	85	96	90	312	78	8
	14	19	80	57	49	205	51	5
	15	1	7	12	5	25	6	1
	16	6	32	43	25	106	27	3
	17	33	66	41	35	175	44	4
	18	16	22	24	22	84	21	2
	19	56	64	59	56	235	59	6

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
6	20	21	60	40	47	168	42	4
	21	81	102	95	81	359	90	9
	22	48	44	42	40	174	44	4
	23	44	61	53	51	219	55	6
	24	45	54	72	50	221	55	6
7	1	34	56	43	58	191	48	5
	2	23	35	34	37	129	32	3
	3	27	71	59	46	203	51	5
	4	64	86	51	80	281	70	7
	5	33	40	55	44	172	43	4
	6	62	75	60	78	275	69	7
	7	30	38	36	82	186	47	5
	8	Young	Palm	...	...	...	...	...
	9	64	91	76	75	326	82	8
	10	83	103	106	83	375	94	10
	11	15	29	33	19	96	24	2
	12	50	70	75	66	261	65	7
	13	41	69	54	52	216	54	6
	14	31	24	37	35	127	32	3
	15	22	29	37	37	125	31	3
	16	20	30	27	26	103	26	3
	17	28	54	52	40	174	44	4
	18	22	125	48	48	243	61	6
	19	83	95	68	90	336	84	9

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
7	20	19	40	41	39	139	35	4
	21	70	105	89	85	349	87	9
	22	60	78	79	54	271	68	7
	23	52	83	96	61	292	73	7
	24	32	107	63	60	262	66	7
8	1	12	24	28	28	92	23	2
	2	42	48	43	59	192	48	5
	3	33	46	56	61	196	49	5
	4	63	78	74	74	289	72	7
	5	68	87	81	64	300	75	8
	6	44	78	83	74	279	70	7
	7	44	66	47	53	210	53	5
	8	30	95	72	73	270	68	7
	9	77	100	87	89	353	88	9
	10	58	68	63	66	255	64	7
	11	61	93	78	66	298	75	8
	12	15	27	36	30	108	87	3
	13	30	43	35	31	139	35	4
	14	33	54	57	46	190	49	5
	15	66	84	81	76	307	77	8
	16	17	38	42	28	125	31	3
	17	13	32	29	43	117	29	3
	18	24	25	45	30	124	31	3
	19	26	48	32	39	145	36	4

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
8	20	36	57	40	47	180	45	5
	21	44	80	62	43	229	57	6
	22	37	66	50	53	206	52	5
	23	34	71	35	35	175	44	4
	24	0	7	10	7	24	6	1
9	1	44	71	58	50	223	56	6
	2	36	7	48	65	156	39	4
	3	75	100	71	93	339	85	9
	4	35	65	51	59	210	53	5
	5	71	80	84	113	348	87	9
	6	55	109	78	65	307	77	8
	7	79	122	75	78	354	89	9
	8	62	79	77	76	294	74	8
	9	51	63	56	45	215	54	6
	10	50	74	47	67	238	59	6
	11	64	52	55	58	229	57	6
	12	48	73	65	62	248	62	6
	13	16	35	52	41	144	36	4
	14	58	91	74	72	295	74	8
	15	47	103	79	83	312	78	8
	16	6	28	34	37	105	26	3
	17	8	78	22	40	148	37	4
	18	70	111	88	85	354	88	9
	19	71	86	84	89	330	83	8

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
9	20	40	57	46	54	197	49	5
	21	65	89	66	85	305	76	8
	22	45	74	73	51	243	61	6
	23	24	54	29	46	153	38	4
	24	47	69	49	45	210	53	5
10	1	3	15	15	34	67	17	2
	2	32	37	50	53	172	43	4
	3	140	129	91	122	482	121	12
	4	61	95	88	103	347	87	9
	5	29	35	49	43	156	39	4
	6	51	87	74	73	285	71	7
	7	66	95	71	72	304	76	8
	8	20	23	28	32	103	26	3
	9	84	87	80	60	311	78	8
	10	63	65	71	52	251	63	6
	11	35	59	39	48	181	45	5
	12	56	63	65	76	260	65	7
	13	54	75	75	60	264	66	7
	14	1	15	23	33	72	18	2
	15	68	74	92	66	300	75	8
	16	51	72	85	76	287	72	7
	17	66	99	87	56	308	77	8
	18	14	78	49	62	203	51	5
	19	33	62	44	35	174	44	4

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
10	20	9	20	28	14	71	18	2
	21	48	57	63	60	228	57	6
	22	51	84	67	66	268	67	7
	23	42	38	66	34	180	45	5
	24	41	53	68	70	232	58	6
11	1	55	73	74	66	268	67	7
	2	40	48	30	60	178	45	5
	3	80	64	72	77	293	73	8
	4	29	59	59	57	204	51	5
	5	7	30	26	17	80	20	2
	6	75	96	89	103	363	91	9
	7	34	32	41	12	119	37	4
	8	'59	93	70	80	302	76	8
	9	88	48	88	57	281	70	7
	10	89	90	99	74	352	88	9
	11	41	50	46	40	177	44	5
	12	26	131	49	117	323	81	8
	13	51	75	65	79	270	68	7
	14	36	56	44	57	193	48	5
	15	65	77	54	95	291	73	7
	16	13	30	6	45	94	24	2
	17	89	105	118	108	420	105	11
	18	47	128	69	132	376	94	10
	19	46	48	56	68	218	55	6

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
11	20	14	26	27	22	89	22	2
	21	34	93	68	89	284	71	7
	22	21	88	60	39	203	51	5
	23	72	145	53	82	352	88	9
	24	66	58	47	49	220	55	6
12	1	47	92	77	74	290	73	7
	2	101	75	92	99	367	92	9
	3	60	74	63	81	278	70	7
	4	40	62	49	58	209	52	5
	5	44	94	68	61	267	67	7
	6	25	49	45	33	152	38	1
	7	48	95	100	98	341	85	9
	8	70	107	74	77	328	82	8
	9	60	63	68	60	251	43	6
	10	36	47	55	61	199	50	5
	11	28	89	119	99	335	84	9
	12	48	79	71	60	258	47	7
	13	48	53	35	52	188	47	5
	14	81	117	76	103	377	94	10
	15	60	60	50	56	226	56	6
	16	12	24	22	27	85	21	2
	17	45	78	37	86	246	62	6
	18	63	63	56	66	248	62	6
	19	41	63	63	51	218	55	6

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
12	20	27	52	38	51	168	42	4
	21	33	63	43	58	197	49	5
	22	25	60	67	50	202	51	5
	23	19	92	77	30	218	55	6
	24	19	69	54	47	189	47	5
13	1	31	60	60	52	203	51	5
	2	72	107	88	86	353	88	9
	3	70	98	84	87	339	85	9
	4	57	104	89	111	361	90	9
	5	23	40	45	32	140	35	4
	6	34	59	35	60	188	47	5
	7	32	42	46	45	165	41	4
	8	17	35	29	29	110	28	3
	9	72	87	74	85	318	79	8
	10	32	17	74	60	183	46	5
	11	12	19	7	31	69	17	2
	12	67	107	81	99	354	89	9
	13	45	64	70	75	254	64	7
	14	8	26	29	31	94	24	2
	15	36	114	72	77	299	75	8
	16	33	40	59	55	187	47	5
	17	16	54	33	35	138	35	4
	18	32	45	40	56	173	43	4
	19	67	127	89	107	390	98	10

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
13	20	48	88	66	66	268	67	7
	21	47	79	76	101	303	76	8
	22	56	94	73	67	290	72	7
	23	15	34	39	33	121	30	3
	24	44	49	41	31	165	41	4
14	1	68	80	76	71	295	74	8
	2	56	73	68	77	274	69	7
	3	24	73	59	77	233	58	6
	4	4	35	12	1	52	13	1
	5	14	34	35	36	119	30	3
	6	56	68	69	79	272	68	7
	7	64	74	61	69	268	67	7
	8	26	59	41	42	168	42	4
	9	66	74	78	73	291	73	7
	10	135	119	114	91	459	115	12
	11	12	36	23	44	115	29	3
	12	29	69	57	53	208	52	5
	13	63	74	75	66	278	69	7
	14	61	53	71	61	246	62	6
	15	19	38	49	17	123	31	3
	16	16	33	12	12	73	18	2
	17	47	96	71	82	296	74	7
	18	26	32	41	54	153	38	4
	19	13	36	61	89	199	50	5

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
14	20	13	25	11	7	56	14	1
	21	56	91	65	62	274	68	7
	22	68	97	81	46	292	73	7
	23	55	53	63	55	226	57	6
	24	44	77	54	48	223	56	6
15	1	29	84	59	38	210	53	5
	2	44	41	62	54	201	50	5
	3	51	59	60	36	206	52	5
	4	52	150	105	118	425	106	11
	5	54	72	57	69	252	63	6
	6	18	86	66	47	217	54	6
	7	34	55	69	61	219	55	6
	8	68	125	87	101	401	100	10
	9	18	48	49	48	163	41	4
	10	21	54	37	61	173	43	4
	11	37	51	61	69	218	55	6
	12	36	117	100	93	346	87	9
	13	20	34	30	46	130	33	3
	14	69	91	88	89	337	84	9
	15	56	63	57	81	257	64	7
	16	21	24	56	43	144	36	4
	17	14	59	36	48	157	39	4
	18	30	46	52	65	193	48	5
	19	48	32	77	63	220	55	6

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
15	20	45	65	54	56	220	55	6
	21	22	56	61	65	204	51	5
	22	40	83	84	80	287	72	7
	23	58	70	60	70	258	65	6
	24	45	38	56	53	192	48	5
16	1	41	69	68	66	244	61	6
	2	47	71	59	71	248	62	6
	3	36	67	54	41	198	50	5
	4	59	86	83	54	282	71	7
	5	56	114	98	126	394	99	10
	6	33	75	60	107	275	69	7
	7	36	39	47	54	176	44	5
	8	12	38	39	37	126	32	3
	9	50	92	65	96	303	76	8
	10	83	118	91	122	414	104	11
	11	56	74	61	82	273	68	7
	12	67	69	61	60	257	64	7
	13	75	113	66	104	358	90	9
	14	55	128	96	101	380	95	10
	15	33	52	51	46	182	46	5
	16	32	42	43	52	169	42	4
	17	71	65	61	96	293	74	8
	18	53	38	77	70	238	60	6
	19	53	117	77	86	333	82	9

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
16	20	35	56	61	42	194	49	5
	21	15	17	94	18	144	36	4
	22	86	90	98	74	348	87	9
	23	57	79	56	62	254	64	7
	24	40	64	53	64	221	55	6
17	1	53	95	47	63	258	65	7
	2	29	61	58	44	192	48	5
	3	59	81	91	82	313	78	8
	4	44	112	76	78	310	78	8
	5	Young	Palm					
	6	74	96	88	89	347	87	9
	7	60	76	74	95	305	76	8
	8	77	56	45	62	240	60	6
	9	35	55	47	56	193	48	5
	10	Young	Palm					
	11	39	59	94	77	269	67	7
	12	38	49	53	37	177	44	5
	13	65	145	37	52	299	75	8
	14	43	64	64	79	250	63	6
	15	55	94	76	66	291	73	7
	16	11	49	33	31	124	31	3
	17	17	109	91	89	306	77	8
	18	94	124	100	130	448	112	11
	19	44	68	88	50	250	63	6

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
17	20	55	123	108	79	365	91	9
	21	46	111	34	74	265	66	7
	22	42	56	102	67	267	67	7
	23	38	75	78	81	272	68	7
	24	43	68	63	65	239	60	6
18	1	31	59	65	64	219	55	6
	2	44	76	64	56	240	60	6
	3	16	31	43	46	136	34	3
	4	32	68	48	65	213	53	5
	5	61	102	94	96	363	91	9
	6	Young	Palm					
	7	74	85	90	83	332	83	9
	8	40	61	74	63	238	60	6
	9	52	78	98	77	305	76	8
	10	Young	Palm					
	11	47	53	58	61	219	55	6
	12	72	129	100	137	438	110	11
	13	64	90	76	69	299	74	8
	14	42	78	73	82	275	69	7
	15	50	82	73	92	297	74	8
	16	4	15	6	11	36	9	1
	17	35	88	94	75	292	73	7
	18	26	46	58	44	174	44	4
	19	15	73	46	55	189	48	5

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum	Average per picking over 4 years to nearest whole number
18	20	42	55	55	50	202	51	5
	21	32	27	24	26	109	27	3
	22	54	76	57	60	247	62	6
	23	41	92	71	71	277	69	7
	24	26	26	29	21	102	26	3
19	1	18	35	32	31	116	29	3
	2	72	78	75	72	297	74	8
	3	49	63	63	68	243	61	6
	4	74	73	78	84	309	77	8
	5	45	56	42	44	187	47	5
	6	13	23	36	39	111	28	3
	7	40	56	60	52	208	52	5
	8	24	37	44	52	157	39	4
	9	25	55	54	47	181	45	5
	10	90	57	92	99	338	85	9
	11	63	81	68	68	280	70	7
	12	43	73	73	57	246	62	6
	13	43	39	61	38	181	45	5
	14	72	69	71	86	298	75	8
	15	42	54	66	55	217	54	6
	16	58	74	84	62	278	70	7
	17	26	68	87	61	242	61	6
	18	57	62	81	52	252	63	6
	19	13	25	25	15	78	20	2

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years.	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
19	20	70	112	90	98	370	93	9
	21	29	55	38	45	167	42	4
	22	12	24	30	26	92	23	2
	23	46	76	58	59	239	60	6
	24	65	76	71	31	243	61	6
20	1	10	39	24	43	116	29	3
	2	51	82	84	75	192	73	7
	3	34	55	57	66	212	53	5
	4	44	59	49	72	224	56	6
	5	39	57	41	52	189	47	5
	6	75	83	112	95	365	91	9
	7	17	62	53	68	200	50	5
	8	28	5	67	45	145	36	4
	9	42	67	17	54	180	45	5
	10	54	80	79	68	281	70	7
	11	48	40	49	66	203	51	5
	12	24	48	59	45	176	44	5
	13	58	101	72	72	303	76	8
	14	20	64	51	62	197	49	5
	15	28	83	59	47	217	54	6
	16	13	31	30	45	119	30	3
	17	29	75	75	48	227	57	6
	18	45	78	74	80	277	69	7
	19	39	71	49	61	220	55	6

Row	Tree No.	Total 1st year.	Total 2nd year.	Total 3rd year.	Total 4th year.	Total yield for 4 years	Average of 4 years per annum.	Average per picking over 4 years to nearest whole number.
20	20	20	49	51	48	168	42	4
	21	40	57	38	45	180	45	5
	22	41	48	41	35	165	41	4
	23	38	41	52	50	181	45	5
	24	28	43	22	43	136	34	3

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; and the Malay States Information Agency, 88, Cannon Street, E C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV	(1913-16) VIII & IX (1920-21)		price	$5.00 per volume.
Vol. V	(1917)	Nos. 1, 2, 3, 5 & 6	„	2.50 per set.
„ VI	(1918)	„ 1, 7, 8 & 12	„	2.00 „
„ VII	(1919)	„ 2—6	„	4.50 „

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

Vol. X (1922) Price $5.00 per volume.
„ XI (1923) Price $5.00 per volume or 50 cents per single number.

Back numbers of Vols. I—X will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased at the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co.

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, Government Entomologist, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher.
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, Government Entomologist, 1910, reprint 1916, 20 cts.
4. A Lepidopterous Pest of Coconuts, *Brachartona catoxantha, Hamps*, by H. C. Pratt, 1909.
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909.
6. Preliminary note on a Branch and Stem Disease of *Hevea Brasilienisis*, by W. J. Gallagher, 1909.
7. Coffea Robusta, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910.
9. Die-Back Fungus of Para Rubber and of Cacao, by K. Bancroft, 1911.
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher, 1910.
11. Coconut Cultivation, by L. C. Brown, 1911.
12. Padi Cultivation in Krian, by H. C. Pratt, 1911.
13. A Root Disease of Para Rubber, *Fomes Semitostus*, by K. Bancroft, Assistant Mycologist 1912, 20 cts.

C = Cancelled

THE

Malayan Agricultural Journal.

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A REPORT ON THE NIPAH PALM AND THE PRODUCTION OF ALCOHOL IN BRITISH NORTH BORNEO.

By J. H. Dennett.

IT is conservatively estimated that there is an area of at least 300,000 acres of Nipah Palm occurring in British North Borneo, available in blocks up to 5,000 acres. These areas extend up the river estuaries for distances of about nine or ten miles with a depth varying from a few chains to a mile.

In the naturally occurring state the palms grow so thickly that penetration is difficult and they flower but rarely.

The population of British North Borneo being small little exploitation has taken place for any purpose whatever. Initial conditions therefore differ greatly from those in the Federated Malay States, where, owing to exploitation either for attaps or for replacement by other crops, nipah generally, has been reduced to a fringe on the river banks. Nipah in this country thus resolves into an agricultural undertaking whereas in British North Borneo it remains a forest product.

Kuala Samawang.

The areas inspected were situated round the delta of the Samawang river about fifty miles to the northwest of Sandakan. It is here that the experimental plant for the production of motor spirit is situated. The delta above the mangrove region is covered with nipah for a distance of eight to nine miles. The depth varies from two chains to three quarters of a mile. The areas all appeared to be cut at intervals by creeks, from three to fifteen feet wide. This would facilitate collection.

It was found that these areas resembled the so called Nipah Gallah, *i.e.* The leaflets grow straight, almost vertically, a natural consequence of over-crowding, and but little fruiting occurs. Now that thinning has taken place the tendency is for the leaves to spread more *i.e.* to become so called Nipah Padi. Continual fruition is to be

expected as a sequence. The thinned area presents a much healthier appearance, is a better colour and bears much more fruit.

The fruit stalks although not all the same age could not be considered to represent all stages of development. Not one unopened bud was seen over the whole area, a very noticeable difference from this country where fruit may be seen at all stages of development throughout the year.

"Gonchanging" is said to be essential, the yield being thought to be proportional to the amount of preliminary treatment which the stalk receives.

Collection.

All the estimates made in British North Borneo either on the production of alcohol or sugar have been based on a working year of 180 days. It is believed however by thinning out that tapping may be continued for nine or even twelve months per annum; and that all palms will yield.

The area supplying the experimental factory was first tapped in January, 1924 and tapping was continued into June. As mentioned above the palms grow very thickly and it was found necessary after tapping has started to thin them out to about 300 per acre (c.f. M.A.J., Vol. XI, p. 59). In consequence the difficulties of collection were increased owing to the fruit being very scattered.

The juice is collected only once a day although a paring of the stalk is made every twelve hours. Collection is made in bamboo joints. These are emptied into kerosine tins in which the partially fermented liquid is conveyed to sampans. Bamboos are cleaned by smoking them over a fire.

It is considered that one coolie can tap sufficient palms to yield 80 gallons of juice per diem. Each palm is estimated to yield 10 gallons of juice in a season of 180 days This amounts to over 4,000 lbs. of sugar per acre (c.f. M.A.J. estimate of 9,000 lbs. working a full year annually).

Sampans deliver the juice at the factory pier. Payment is made at the rate of 1 cent per gallon. Strength of juice is checked in factory to prevent dilution.

The Factory.

The experimental plant is capable of producing over 200 gallons (Imp.) of motor spirit per day, and was erected for a total cost of $42,000. The whole factory is housed in attap walls with corrugated iron roof. It may be divided into three parts:—

(1) the boiler house where a working steam pressure of 80 lbs. is maintained.

(2) the fermenting room and alcohol store.

(3) the still tower.

The fermenting room contains three fermenting vats of 1,600 gallons capacity each, and an alcohol storage tank of 4,000 gallons capacity. The juice is pumped from the sampans to these vats.

The still tower is conveniently divided into three stages or floors. The floors do not correspond with particular units of plant but are made to render the different parts accessible with convenience

The alcohol fractionating still which is 18 to 20 feet high, and 18" in diameter and containing 25 fractionating plates, runs from the ground to the middle of the first stage, the upper half of this stage being occupied by the condensers. The ether still is almost completely situated on the ground floor, only the condensers being on the first story. The second floor contains the gravity constant pressure feed for the raw juice.

Distillation.

The fermented juice is allowed to stand in the fermenting vats for a period of about 24 hours, after which it is pumped to the feed vat on the second floor from whence it flows at constant pressure to the preheater on the ground floor, passing from that to the bottom of the alcohol fractionating still. Steam is also blown into the bottom of the still, vapourising the preheated fermented juice as it enters. The 25 plates cause a partial condensation of the vapours, the alcohol tending to continue up the tower and the water to run back to the bottom of the still. From the top of the still the uncondensed vapours pass into the dephlegmator or preliminary condenser where a further separation of alcohol and water tends to take place, owing to any water vapour still present condensing more readily than the alcohol, which tends to pass on to the condenser proper.

The condensed liquid, still containing a small amount of alcohol, passes back to the top of the tower by syphon, flowing down towards the base, to met by hot vapours passing up the tower This liquid acts as a condenser to the water in the hot vapour while the latter vapourises the alcohol contained in the former.

In this manner a continual process of vapourisation and condensation takes place, alcohol vapour tending to pass on, water vapour tending to condense, until finally an almost complete separation of water and alcohol has been obtained, alcohol vapour passing through the dephlegmator, being liquified in the condenser proper, and water, free from alcohol, being run off at the bottom of the still

The alcohol, unrectified and containing about four per cent. of water, flows to the alcohol storage tank on the ground floor.

Ether.

The ether plant is similar in principle and working to the one for the production of alcohol, but on a smaller scale. It has however a different unit in the lead-lined, steam-jacketed chamber where ether is formed by the re-action of concentrated sulphuric acid and alcohol.

Sulphuric acid extracts one molecule of water from two molecules of alcohol forming ether. This is well expressed in the followng chemical equation :—

$$C_2H_5\ \boxed{OH + H}\ OC_2H_5 = C_2H_5OC_2H_5 + H_2O$$

(alcohol + alcohol = ether + water)

The requisite amount of concentrated commercial sulphuric acid is run into the reaction chamber together with the proper proportion of alcohol for the start for the reaction. The vessel is maintained at a temperature of 140°. The ether volatilises as it is formed and passes to the bottom of the ether fractionating still. Here a similar process of vapourisation and condensation takes place to that occurring in the alcohol still. Before passing into the dephlegmator the ether vapour passes through the deacidifier which contains caustic soda. This removes any sulphurous acid (due to the partial decomposition of the sulphuric acid) which the ether may contain. The vapour passes on to the dephlegmator and condenser proper, condensed alcohol and water being returned to the still.

The process is continuous, alcohol being regularly drawn into the reaction vessel until the sulphuric acid is too dilute to react further.

The condensed ether flows from the condenser to the storage tank on the ground floor. The storage tank is itself fitted with a condenser owing to the volatile nature of ether. Water is continually pumped through this condenser, and from there to the two condensers situated on the first story.

Motor Fuel.

Thirty per cent. of ether and seventy per cent. of alcohol are generally mixed together with the addition of 1 per cent. of aniline, the latter partly as a denaturiser and partly to neutralise the acid exhaust gases which are obtained on combustion of alcohol and ether. This addition of aniline constitutes the Foster Patent. Fifteen per cent. of ether to eighty-five per cent. of alcohol has been used experimentally but no details of trials were available.

Trials.

The 1,000 gallons of motor spirit produced in the experimental plant during 1924 are being used in the P.W.D. lorries in Jesselton. It is claimed, with proper adjustment, an 80% efficiency is obtained compared with petrol. Engines are said to require less lubricating oil, to be free from over heating, boiling radiators, and to require decarbonising less frequently.

From figures which were available, the following estimates which appear to be conservative, are given.

Estimate A.

Present Experimental Plant.

Maximum Capacity 200 gallons of motor spirit per day (180 days per annum only).

	Running 12 hours daily.	Running 24 hours daily.
	$	$
Collecting costs ...	3,300.00	6,600.00
Distilling costs ...	4,620.00	7,020.00
Other costs (Depreciation inclusive)	15,370.00	21,790.00
Gallons of Motor Spirit ...	18,000	36,000
All in cost per gallon ...	85.38 cents	60.50 cents

Estimate B.

Plant of maximum capacity of 2,000 gallons of motor spirit per day (180 days per annum only).

	Running 12 hours daily.	Running 24 hours daily.
	$	$
Collecting costs ...	33,000	66,000
Distilling costs ...	19,185	31,170
Other costs (Depreciation inclusive)...	24,600	31,800
Total ...	76,785	128,970
Gallons of motor spirit ...	180,000	360,000
All-in cost per gallon in cents ...	42.65	38.82

Estimate C.

Plant of maximum capacity of 4,000 gallons of motor spirit per day (180 days per annum only.)

	Running 12 hours daily.	Running 24 hours daily.
	$	$
Collecting costs ...	66,000	132,000
Distilling costs ...	30,210	61,920
Other costs (Depreciation inclusive)...	42,000	57,600
Total ...	138,210	251,520
Gallons of motor spirit ...	360,000	720,000
All-in cost per gallon in cents ...	38.38	34.93

ESTIMATE D.

Plant of maximum capacity of 8,000 gallons of motor spirit per day (180 days per annum only).

Collecting costs	...	132,000	264,000
Distilling costs	...	60,960	103,320
Other costs (Depreciation inclusive)..		78,000	106,800
Total	...	270,960	474,120
Gallons of motor spirit	...	360,000	720,000
All-in cost per gallon in cents	...	37.63	32.92

It would appear from these figures that an economical undertaking would be the erection of a 4,000 gallon plant running 24 hours per day.

The percentage of the various heads of expenditure are summarised below.

		12 hours daily.	24 hours daily.
Collecting.			
Present 200	gallon plant.	21.48 per cent	30.35 per cent.
2,000	do	13.00 „ „	51.20 „ „
4,000	do	17.75 „ „	52.50 „ „
8,000	do	48.75 „ „	55.75 „ „
Distilling.			
Present 200	gallon plant	30.10 per cent	32.20 per cent.
2,000	do	25.00 „ „	24.19 „ „
4,000	do	21.85 „ „	24.61 „ „
8,000	do	22.50 „ „	21.80 „ „
Other Charges.			
Present 200	gollon plant.	48.42 per cent	37.45 per cent.
2,000	do	32.00 „ „	24.61 „ „
4,000	do	30.40 „ „	22.89 „ „
8,000	do	28 „ „	23.45 „ „

The scheme for costs for working these larger plants is based on experience gained with the running of the present plant. It will be noted that the cost of collection is the heaviest head of charges for the larger scale operations, being always directly proportional to the quantity or motor spirit produced. In these larger scale estimates such costs as a head distiller, a visiting doctor, hospital, etc. are taken in account.

In the case of the 4,000 gallon plant running 24 hours per diem and the 8,000 plant, a superientendent at $600/- per mensem is included in the distilling charges. This accounts for the slight anomalies which will be noticed in the percentage costs under that heading.

Under the heading other costs it will be seen that the same depreciation is allowed, for the 24 hour operations as for 12 hour. Although this appears to be anomalous it must be remembered that it is estimated that the plant is running only 6 months per year. 10% depreciation may be considered quite high on such a plant, if running throughout the year. Thus it would appear rather that depreciation has been placed at too high a figure in the 12 hour, rather than too low a one in the 24 hour estimate, in order to be conservative.*

COMPETITION.

Enquiries were made with regard to competition from petroleum interests. In British North Borneo an import duty is levied on petrol, but it is understood that in the Phillipines over two million gallons of alcohol are produced and used as motor fuel annually. This has led to no cutting in prices by the oil companies operating there, although alcohol motor spirit is cheaper than petrol even allowing for the fact that petrol is 25% more efficient (petrol itself is considerably cheaper in P. I. than locally). In this connection it was learnt that alcohol motor spirit is produced from molasses in the Phillipines at 29 cents (Straits) per imperial gallon.

Production in Borneo on a large scale at the present time would necessitate a sale in Singapore and Malaya generally. It is estimated that it could be sold wholesale in Singapore at a price appreciably lower than that of petrol. It would seem therefore that local producers would have a substantial advantage over competitors producing in

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*Estimates of all-in costs of plant for various sizes have been placed at the following outside figures

Maximum capacity per day in gallons	Copper stills. All in cost. $
2,000	150,000
4,000	300,000
8,000	600,000

This figures are all very high, the larger plants costing less comparatively than the smaller ones. Redwood stills are considerably cheaper.

Mr. C. M. Hudson representing the Foster motor alcohol patents in the East gave the following approximate costs for a 2,000 gallon still manufacturing alcohol of 95% purity.

Copper	...	$35,000
Redwood	...	$20,000

F.O.B. Manila.

other countries, which would go towards realisation of interest on capital sunk in planting.

Conclusions.

From all the information obtainable in *British North Borneo* it appears that if areas, sufficiently large to keep the factory running are available, nipah can be efficiently and economically exploited for the production of alcohol and motor fuel at a price sufficiently low (after consideration of its 80% efficiency with proper carburettor adjustments) to compete successfully with petrol.

Thanks are due to Mr. D. D. Woods, Conservator of Forests, B.N.B., whose courtesy rendered this visit possible.

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A NOTE ON *LAELIA SUFFUSA*, WLK. (LYMANTRIIDAE) DAMAGING PADI.*

By

B. A. R. Gater and Mohammed Yusope.

Introduction.

During December 1924 about ten acres of padi situated at Sungei Star, near Parit Buntar, was attacked by leaf-eating caterpillars. Specimens were forwarded to the Entomological Laboratory asking for advice and stating that the plants were very stunted and weak as the result of the attack. Examination showed the presence of the Pyralid, *Cnaphalocrocis medinalis*, Guen. and some unknown Lymantriid larvae, the latter in considerable numbers. The larvae were bred out and the moths provisionally identified by the senior author as *Laelia suffusa*, which has not been recorded as a pest of padi as far as can be ascertained from the literature available.

Laelia suffusa has been mentioned by Joannis (4) as injurious to sugar cane in Java, while Duport (3) says it is a pest of this plant in the Far East. *Laelia* sp is recorded on peanuts by Jarvis (6) *L. adara*, Moore, on sugar cane in Java by Joannis (4) and *L. devestita*, Wlk. is recorded as having been reared from larve on sugar cane and guinea grass at Pusa by Fletcher (7). *Laelia suffusa* has been described under the specific names of *angulifera*, Wlk., *prolata*, Swinh. and *subrufa*, Snell., while its distribution is given by Seitz (5) as India, Ceylon, Java, Celebes, Luxon, and Bago. It has thus not been recorded in the Malay Peninsula as far as can be seen from the available literature up to that date. It is unrepresented in the F.M.S. Museum.

Life History.

The moths copulate on the same day as emergence and the female begins to lay eggs on the following day. During the daytime the moths are quiescent, being active only in the evening and at night. The total life in captivity of the male was 8 to 9 days and of the female 5 to 12 days. Eggs are laid for a period of about 4 days, the greatest number laid by a single female in the laboratory being 176. An examination of the ovaries, however, revealed the presence of numerous undeveloped eggs, and the total possible number appears to be well over 260. The moths have not been observed feeding, and the haustellum is very short.

The eggs are laid in straight rows along the stem of the food plant, being cemented on by a transparent, slightly frothy, cement. Hatching takes place in from 6 to 7 days after oviposition, the larvae

* The identification is provisional, and will be confirmed later. See the remarks under " Description of Stages, the Imago ".

emerging at the sides of the eggs and eating a portion of the shell as their first meal. They then rest, and do not begin to feed on the food plant for two days.

The larval life lasts from 25 to 37 days, the full grown caterpillars spinning their cocoons in a few hours and pupating on the following day. The duration of the pupal stage is from 8 to 13 days. In the laboratory there appears to be a preponderance of males, some egg masses producing no females at all. Out of 59 adults bred to date, 32 are males. There is some slight indication that the first batches of eggs produce males, females only coming from the later batches, and since it appears that the full number of eggs is not laid in captivity the preponderance of males would appear to be explained.

The following is a summary of the life history :—

Period.		Range.	Mean.
Emergence to oviposition	-	1	1 day.
Incubation	-	6 – 7	6½ days.
Larval period	-	25--37	30 ,,
Pupal period	-	8--13	9½ ,,
		10 --58	47 days.

Description of Stages.

The Egg —The egg is roughly 0.75 m/m in diameter and 0.5 m/m high, and is of a light buff colour. The general shape is round, but two sides are flattened, these sides being in juxtaposition when the eggs are deposited in a row on the food plant. An examination of the eggs while still in the eggs-tubes shows that the flattening of the two sides is present before they are laid. On the two rounded sides there is a sub-marginal band of light green. The top is flattened, and depressed in the centre round the prominent micropyle. Chorion minutely tessellated. Just before hatching the colour changes to light grey.

The Larva. On hatching the larva is 2 m/m in length and light greenish black in colour. The head is shiny black in colour and large, while the legs and prolegs appear to be disproportionately long Long black hairs arise from small tubercles on the segments, those arising from two large tubercles on the first thoracic segment being the longest.

The full grown larva consists of 12 segments with the prolegs on abdominal segments 3 to 6. It is 20--35 m/m in length. Head dull ochreous with a black band round the mouthparts. Clypeus and antennae white, labrum bifurcate with a distal white margin; mandibles black. Five ocelli are present on each side of the head, a group of four within the black band and a single one below,

The general colour of the body is black, varying from velvet black on the dorsum to a lighter greenish black laterally and ventrally. Spiracles on the 1st thoracic and on abdominal segments 1 to 8 white with black edges. There is a longitudinal sub-dorsal stripe of canary yellow on each side, the colour deepening to orange yellow in the centre of each segment. Sub-laterally there is a pink-white stripe which is white between and pink in the centre of each segment. Two subdorsal and two sublateral rows of papillae are present, from which arise groups of long, slightly plumose, brown hairs. Two long pencils of black hairs project forward from the first thoracic segment, the ends of these hairs appearing to be club-shaped owing to the lengthening of the plumes. Tufts of reddish brown hairs are present on the dorsum of abdominal segments 1 to 4, while a small tuft of similar colour is situated on the 8th abdominal segment From the centre of the latter there arises a pencil of black hairs similar to those on the 1st. thoracic. A glandular papilla is situated mid-dorsally on abdominal segments 6 and 7.

The writers have not had an opportunity of examining the original paper by Joannis (4) but the statement that this insect is inconspicuous when on its food plant, which appears in the extract given in the Review of Applied Entomology, appears to be somewhat peculiar in view of the very conspicuous colouration of the larva.

The Cocoon. The cocoon is ovoid, rather loose in structure, drab or light brown in colour and composed of silk and larval hairs. The male cocoon is 15 m/m long and 9 m/m broad, the female cocoon being 25 m/m long and 11 m/m in breadth. One end is rounded, while the other is pointed and left open for the emergence of the adult : the hairs on this portion are derived from the pencils on the 1st. thoracic segment of the larva, and are arranged axially to the cocoon.

The Pupa. The pupa is light brown in colour, with darker brown at the junction of the segments, producing a slightly banded appearance. Length in the male 10 m m and in the female 13 m m ; general appearance stout There is a slight dorsal ridge on the thorax, which is lightly clothed with hairs on its dorsal surface There are 8 visible abdominal segments, segments 1 to 8 having a number of small tubercles placed dorsally in oval-shaped groups. Abdominal segments lightly clothed in long fine hairs. Spiracles slit-like and prominent, dark in colour. One or two small tubercles may be present subdorsally on each side of the anterior portion of the 4th abdominal segment, two being present especially in some males.

The Imago. The description given by Seitz (5) Hampson (2) and Moore (1) of this species varies to some extent, and some difficulty was found in fitting the specimens obtained to the description of the species given by these authors. Thus in Seitz the male is described as having *seven* spots on the forewing whereas in Moore it is described as having *six* only. It is not claimed that the species in question is definitely *suffusa*, Wlk. but as far as can be seen it is very near, although the differences between it and the description of *lilacina* Moore are small. The much darker hind wing of the male in the

Malayan insect points to it being nearer the latter species, but the spots are not arranged in quite the same way, the forewings are decidedly pink and there is no evidence of the violet tint mentioned in the description of *lilacina*. The description of the larva in Seitz appears to agree in general with the description given above. The name must remain uncertain until specimens from here have been compared with type specimens. The following rough description is given to show the differences from the description in Seitz :—

Male. Expanse 24 m/m. Head, palpi and legs ochreous ; long hairs from thorax light pink at base. Body white anteriorly, light fuscous posteriorly and light ochreous below. Forewings pale pink suffused with light ochreous scales in costal area. Six black submarginal spots, posteriorly incurved, the proximal spot being the largest ; hind-wings fuscous.

Female. Expanse 34 m/m. Head, palpi, collar and legs ochreous. Body white, suffused with ochreous below. Forewing very pale ochreous, almost white ; hindwings white.

The following description is taken from Seitz :—

" *Male.* Extremities ochreous, body and forewing white, with a faint reddish hue, the forewing with a submarginal row, posteriorly incurved as far as the middle of the dorsal area, of seven black spots. Hindwing pale, towards the margin hued darker."

" Female Head, thorax and forewing uni-coloured, light ochreous, abdomen and hindwing white."

" Larva. Black, with long whitish hair, with tufts of long, spatulate, black hair on the sides of the 1st, and in the middle of the 11th segment, the 4th to 7th segments with four brown dorsal pencils, the 9th and 10th segments with round, whitish dorsal tubercles, one subdorsal and one sub-lateral yellow line, as well as yellow lateral streaks. Head and legs brown or black."

It should be noted that the figure given in plate 12 of Seitz shows the female as being smaller than the male, whereas in all the specimens reared in the laboratory the reverse is the case.

ECONOMIC IMPORTANCE.

Apart from a few notable exceptions the Lymantriidae do not constitute pests of any great importance, and therefor attacks of great severity will probably not occur. In Malaya, however, so little is known of the common pests and so many unrecorded pests are continually being found, that caution is required in dealing with any unfamiliar insect. No parasites have been found on this insect, but collection of eggs and caterpillars in the field may eventually yield one or more. In the absence of parasites this insect may do considerable damage to padi, comparable to that done by other caterpillars which every now and then destroy several nurseries. Any specimens seen which resemble the foregoing description of the caterpillar should be forwarded to the Entomological Laboratory with notes of the area

attacked, locality, etc. so that more information can be obtained. At present little more than hand-picking can be done on Malay small-holdings, but the ordinary derris extract as made here would form an affective spray against the younger caterpillars. In the laboratory the larvae feed indiscriminately on padi, maize and several grasses. It is therefore possible that the wild grasses which surround padi fields will harbour the pest, and they should be cleared away as much as possible, especially during the time when there is no padi on the land and during planting out.

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LATEX PAPER.

By B. J. Eaton.

SOME three or four years ago, considerable interest was aroused in the rubber and paper and pulp world as a result of investigations carried out by Kaye on the addition of latex to pulp for the manufacture of paper.

It was originally suggested by Kaye that the addition of latex to pulp in the manufacture of paper reduced considerably the time of beating required for the manufacture of the pulp and it was considered possible to prepare a cheaper and stronger paper by the addition to the pulp of latex equivalent to 1 to 3 per cent of rubber on the weight of pulp. Although no information as to cost is available at the moment, about a year ago, when our investigations were commenced, the price of latex paper was about 20 to 30 per cent higher than that of similar grades of non-latex paper

Except for (a) sentimental reasons, in respect of firms, estates and others who were interested in the consumption of more rubber and new uses for the commodity or (b) for special purposes in which a stronger or more durable type of paper was required, such as for documents which have to be stored or (c) unless the addition of latex cheapened the cost of manufacture, the use of latex in paper manufacture was not likely to be a success

The application of latex to newsprint paper would only be successful, if the paper could be produced more cheaply, which does not appear to be the case up to the present. The use of latex paper therefore would be confined to paper required for special purposes, principally for documents which have to be stored. The most desirable property of such a paper is its keeping qualities or non-deterioration on storage. The results of several previous investigations carried out in the Bureau of Standards United States of America and by other workers indicate that any superior qualities conferred on paper by the additin of latex to the pulp are lost after the paper has been stored, and this is attributed to the resinification of the rubber. Owing to the fct that the amount of latex or rubber originally added to the paper tested was unknown, as also the original resin content, no investigations were carried out by us to determine whether the rubber originally added to the papers in the form of latex was resinified since such an investigation would have been of no value in the absence of such figures. It seems highly probable however that the rubber would be converted into resinous substances during prolonged storage or under accelerated ageing conditions.

In "The Rubber Age" (Volume V. No. 9 November, 1924, published in England, Kaye has replied to various criticisms of latex paper which were based on investigations on latex papers carried out

TABLE IX.

Paper	Mean Tensile Strength in grm per sq. m.m.	Mean percentage Deterioration of Tensile strength under condition. (b)	(c)	(d)
Control	3412	– 16.75	f 2 50	f 33.00
Kayes	3353	– 7.28	f 13.33	f 39.65
Java Latex	2783	– 0.46	f 49.10	f 57.30
100% Straw	2692	f 2.40	f 26.43	f 16.85
Howards "A"	2171	f 3.20	f 16.88	f 20.35
Howards "B"	2284	f 2.10	f 23.31	f 40.60
Kalatex	2196	f 4.88	f 17.77	f 18.55
Stock Latex	1816	f 3.11	f 48.15	f 16 04

– Represents an increase as compared with condition (a)

f Represents a decrease as compared with condition (a)

OBSERVATIONS.

The results of tests carried out on the stored samples of paper indicate that of the two comparable papers Control (1) and Kayes (2) the latter containing latex deteriorates more under conditions storage (b) (c) and (d); the two papers Java Latex (6) and Java Straw (7) the latex paper deteriorates less under the laboratory conditions (b) but considerably more under conditions (c) and (d). In the case of the two papers Howards "A" without latex (4) and Howards "B" with latex (5) the figures show that the latex paper deteriorates less in the laboratory but more in the oven and in direct sun-light.

No observations can be recorded on the results obtained from comparable chemical tests carried out on the papers after storage under the different conditions specified. It was hoped to be able to record the results of an examination for resinification on the stored latex paper : the chemical tests however did not yield results of any value, and it was decided to confine the observations to physical tests. It may however be recorded in passing that writing in various coloured inks on the different papers was equally affected for all samples during ageing.*

In studying the figures recorded for breaking strain and elongation at break after deterioration and comparing these figures with those recorded in the preliminary report due regard must be paid to the variations in atmospheric humidity during the two periods of

* see Latex paper by B. J. Eaton. p.p.

testing, and that the length of the test strip in the aged samples was 3.0 cms shorter than that in the fresh samples.

Conclusions :—From the results of the above tests it appears that there is little to choose for general purposes, between a paper made from any particular pulp with and without latex. The latex paper certainly exhibits superior tensile properties when fresh.

After storage, the latex paper, although it retains its superiority to folding, exhibits a greater deterioration generally and this deterioration is enhanced by strong heat and direct sun-light.

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SOME OBSERVATIONS ON THE MALAYSIAN COCONUT ZYGAENID (*ARTONA CATOXANTHA* HAMPS)*

By B. A. R. Gater.

INTRODUCTION.

RELATIVELY few insects have as yet become of major importance in the Malay Peninsula, due in some part to the undeveloped state of the country agriculturally, but coconuts are next in importance to rubber as a planting proposition, and any insect which seriously affects them becomes at once of first-class importance. The following summary of observations is the result of numerous investigations during a period of two years over a wide area.

One of the difficulties in studying this insect is the fact that it is sporadic and is hardly ever reported until several broods have occurred, so that the first stages of the outbreak is never seen by the Entomological Staff. The majority of these outbreaks has so far occurred on native holdings, some of them not easily accessible: rarely has the pest affected European-controlled estates. The fact that the pest is notifiable under the Agricultural Pests Enactment assists in its presence being reported early, but the apparent inability of the cultivator to see the caterpillars until the leaves are swarming with them delays the information until too late for the investigation of the earlier stages. The result of this is that the causes of outbreaks are unknown, and shortage of personnel has prevented a member of the staff being stationed in a possible locality to watch for the beginning of an attack.

Happily the attacks are always eventually controlled by natural enemies. As it is, the damage done is considerable, and were the insect to be imported into a country without its natural enemies the danger would be of the gravest character.

Not only is the biology of this insect of great importance to the coconut industry in Malaysia, but it is also of importance in that

*It is intended to follow up this preliminary account with more extensive studies of the various phases of the *catoxantha* problem.

efforts are being made to use its parasites to control a nearly related Zygaenid which is destroying the coconuts on one island after another in Fiji.

Acknowledgement is due to those gentlemon who have materially assisted the production of these notes by the loan of records and in many other ways, particularly F. W. South (Chief Field Officer), C. T. Darwent (Medical Officer, Batu Gajah), and T C. A. Cleverton (Medical Officer, Labuan); and Dr. Guy A. K. Marshall (Director, Imperial Bureau of Entomology) for the identification of species. Mention must also be made of the valuable assitance received from Mohammed Yusope, Junior Agricultural Assistant in the Entomological Laboratory.

HISTORY.

The moth was first described as *Brachartona catoxantha* by Hampson (1) in 1892 from specimens taken in the Tenasserim Valley. Dr. K. Jordan (4) however, includes *Brachartona*, Hamps. in *Artona*, Walk. The first mention of a food plant in literature appears to be by Ridley (2) in Malacca, but Pratt (3) writing of an attack at Batu Gajah in 1907 mentions that it was said to have been known there seven years before, about 1900. In 1908 Königsberger (5) described some of the stages, but failed to find the eggs. Since 1909, when Pratt (6) published an account of its life history and suggested control measures, the number of reported cases appears to have increased. Whether this is due to an actual increase and spread or to more frequent and accurate diagnosis it is difficult to say, but on the whole it would not seem unreasonable to assume that attacks are more prevalent now than in the past.

As far as is shown by the available records for Malaysia, *catoxantha* is the only Zygaenid of any economic importance. According to Jordan (4) *Artona lucasseni*, Snell. feeds on *Bambusa* while *A. quadrisignata*, Snell and *A. trisignata*, Snell. feed on an unidentified plant known as "Dawon Houndjek," in Java. *Levuana iridescens*, Baker, is a serious pest of coconuts, as well as feeding on other palms and banana, in Fiji. The life history and habits of the latter insect are similar to *A. catoxantha*, and the co-operation of this Department was sought by the Fijian Government in order to control it by the introduction of parasites from Malaya.

DISTRIBUTION.

Jordan (4) gives the distribution of the genus *Artona* as Indo-Malayan extending northwards to North-East Thibet and eastwards to the Celebes. *Artona catoxantha* has been recorded from Java, Sumatra, Labuan, Sandakan and Malaya. Within the Malay Peninsula it has been recorded at Batu Gajah; several districts in Province Wellesley, Perak and Selangor; at Johore Bahru, Malacca and Singapore. The presence of the feeding marks made on the pinnae by the caterpillars has been noted on nearly every coconut estate visited in Malaya. The feeding marks are so typical, and differ so markedly from those made by any other known coconut insect, that it should

be safe to assume that the distribution in the Malay Peninsula is general. Outbreaks tend to recur in certain localities, notably at Batu Gajah. Little evidence is forthcoming as to whether this is an introduced or indigenous insect, except the number of parasites affecting it, from the extent of which it may be assumed that it is indigenous. Recently, however, an attack occurred at Pulo Kuraman, an island near Labuan. From there the pest spread to other small islands in the vicinity and to the nearest point on the island of Labuan, where it almost immediately died out. None of the typical feeding marks could be found on the coconuts in Labuan and since the coconuts at Pulo Kuraman were planted on newly felled land where none existed before, it did not appear that the insect had originated either in Pulo Kuraman or Labuan. The absence of parasites, and the total absence of the Tachinid so common elsewhere, forces the conclusion that the pest was imported. There are many ways in which this could be done, and evidence from the Labuan area points to a definite danger of spreading this insect by the unrestricted importation of coconut material.

LIFE HISTORY.

Unfortunately the moths have so far refused to copulate in captivity and great difficulties have been encountered in rearing the young caterpillars under laboratory conditions. The life-history has thus been worked out only in piecemeal form, probably with not very accurate results. The time taken by the various instars to develop has, however, been found to be sufficiently accurate for calculations in the field. Outbreaks of this insect have rarely occurred on young easily accessible palms, the older palms usually being affected. It is intended to study the life-history further by mass methods on small growing palms.

Copulation appears to take place on the same day as emergence, the male dying one or two days after. Eggs are laid from two to three days after copulation, the female dying the day after oviposition. In the field however, the length of the adult life is probably much longer than is indicated by those figures, and may last as long as two weeks. Eggs are laid singly on the under surface of the pinnae, generally towards the tip, the older rather than the younger leaves seeming to be preferred for oviposition. The average number of eggs laid appears to be 40, but instances have been observed in which as many as 57 have been deposited by a single female.

The Egg.

The egg is slightly oval in shape, smooth, slightly flattened and of a translucent pale yellow colour. Average size 0·5 x 0·25 m/m.

The incubation period is three to five days (observed range) the mean period being four and a half.

The Larva.

The first instar is only a millimetre in length and pale greenish-yellow in colour. The thorax is broader than the abdomen, which

tapers towards the anal claspers. Duration four to five days. The second instar is about 2 m/m in length and is more visibly hairy. After an interval of 4 to 5 days the second moult takes place, the third instar being similar to the second except in size, which is now 3—4 m/m. The duration of the third instar is about 4 days. The fourth instar is 4—6 m/m in length, the coloured dorsal markings of the full grown larva being apparent. Duration four days. The fifth instar is 6—8 m/m long, with ten abdominal segments. The greatest breadth is now at the first abdominal segment, which is very little broader than the rest of the body. The head is invaginated into the first thoracic segment. Mandibles dark brown with sharp untoothed edges. Prothorax and metathorax yellow, the prothorax being larger than the other thoracic segments and shaped like a cowl. Abdomen pale yellow, frequently with a green tinge, legs on thoracic segments small, prolegs on abdominal segments 3 to 6, anal claspers on the 10th. On the mid-dorsal surface of the abdomen there is a longitudinal blue or purple fascia, extending from the third thoracic to the ninth abdominal segment. Small areas similarly coloured may be seen on the sides of the 3rd thoracic and on the 1st and 8th abdominal segments, while a larger area is present on the mid-dorsum of the 9th abdominal. Glandular hairs are present in groups situated in longitudinal lines along the body, one group to each segment. There are two subdorsal rows of these groups of hairs and a lateral row extending from the 3rd thoracic to the 8th abdominal segment. On thoracic segments 2 and 3 there are five groups on each side, and on abdominal segments 3 to 6 there are 4 rows, the extra groups being sub lateral in each case. The first thoracic and tenth abdominal segments bear no groups of hairs but are fringed on their distal portions. The ninth abdominal has two groups on each side placed sub dorsally and close together. The hairs of the first or upper subdorsal row of groups are of medium length. The hairs of the second or lower subdorsal row are of the same length but with one long hair arising from each group, whereas in the lateral row there are several longer hairs arising from each group.

The Cocoon and Pupa.

The full grown larva spins a tough papery cocoon which is dirty white to fawn in colour. It is elliptical in shape, 11—12 m/m long, 5—6 m/m broad and flattened on to the leaf.

The pupa is 7—8 m/m long and immediately after its formation is of a light translucent yellow colour. The ten abdominal segments are still visible and a row of short spines is present on the anterior dorsal portion of segments 3 to 7 in the female and 3 to 8 in the male. It is by means of these spines that the pupa is enabled to make its way out of the cocoon just before the moth emerges. At the apex of the tenth segment there is a small group of short blunt spines. The colour gradually becomes darker, and just before emergence the colours of the adult can be clearly seen.

The Imago.

The following description is modified from Pratt (6) and is fuller than that given by Hampson (1):—

Length 7—8 m/m., wing expanse 13—16 m/m. Upperside uniform chocolate brown. Scales on anterior portion of prothorax and posterior portion of head yellow, showing as a collar. Frons yellow with a median brown stripe. Palpi yellow. Costa of forewings yellow; scales fringing both wings lighter brown to yellow; costal margin of hind wing dirty white to yellow. Underside of forewings lighter brown with costa yellow, the yellow terminating broadly near the tip. A broad yellow band along the costal margin of hind-wing, divided by a radial brown stripe; posterior portion of hindwing uniform with forewing. Underside of body and legs, yellow; antennae chocolate brown, often showing a bronze tint, especially in males, and slightly yellow towards the tip in some females. Genital aperture fringed with long yellow scales. Female slightly larger, antennae filiform Male with pectinate antennae.

The following is a summary of the life history :—

LIFE HISTORY OF *ARTONA CATOXANTHA*

Period.		Range :— Days.	Mean :— Days.
Copulation to oviposition	-	2 — 3	2·0
Incubation of egg	-	3 — 5	4·8
Instar I.	-	4 — 5	4·6
Instar II.	-	4 — 5	4·8
Instar III.	-	3 — 5	3·6
Instar IV.	-	3 — 4	3·9
Instar V.	-	6 — 7	6·7
Pupa	-	8 — 10	9·0
		Total	38·9 days.

HABITS.

As soon as the young caterpillars hatch they begin feeding on the epidermis of the underside of the pinnae in straight lines. The feeding marks are typical and have the appearance of ladders. At the beginning of an outbreak the caterpillars are confined to the lower leaves of the palm, but as they increase in numbers during successive broods they swarm over every portion of the plant, even to the spathe and nuts. Königsberger (5) states that feeding takes place on the upper surface of the leaf, but this cannot be said to be the habit in Malaya. A few catérpillars may occassionally be seen on the upper surface, but practically the whole of the feeding is confined to the lower surface. During the last instar feeding may also take place by the ordinary method among caterpillars, namely by eating the edges of the pinnae.

Cocoons are spun on the underside of the leaves at first, and, in the later broods, on any portion of the palm including the stem.

Such quantities of caterpillars are present in bad outbreaks that every available space is occupied by the feeding caterpillars and old cocoons, and cocoons may often be found on the ground and on low-growing plants in the vicinity. During the larval stage hundreds of caterpillars can be made to drop down by shaking a leaf, and they remain suspended by thin silken threads. It is these caterpillars which eventually spin their cocoons on the ground and surrounding plants, since they are not always able to reascend the palm when once they have dropped. The larval hairs are poisonous to a certain extent, sufficient to deter coolies from ascending a palm infested with caterpillars.

The moth has not been observed feeding, and Corbett and South (12) state that there are strong indications that feeding does not take place. The haustellum is, however, well developed, and it is probable that the moths feed in some way not yet determined. According to the same observers the moths are not attracted by light or sugar mixtures, fly actively between 9 p.m. and 6.30 p m. and again between 6.30 a.m. and 2 a.m. Resting periods occur during the remainder of the day, during which they may be seen clustered on the pinnae, especially of the upper leaves, in a semi-erect attitude. The moths do not appear to be strong flyers, most of the flying being probably done by the males. They spread from tree to tree slowly, the line of spread being generally along the edges of open spaces such as roads. The length of the flight can, however, be aided to a great extent by wind. In Labuan (15) flights up to two miles have been observed when aided by a strong wind, but on arrival the moths died and no eggs were laid.

FOOD PLANTS.

The principal food plant is the coconut palm. Other palms are attacked but only, so far as has been seen, when they are in the vicinity of coconuts during an outbreak. Feeding marks have never been observed on any other palm than coconut, but in one instance a dead caterpillar which appeared to be *Artona* was found on a nipah palm, and it had been parasitised by a Chalcidoid similar to one observed in Batu Gajah. During the periods when there is no outbreak repeated search of the area has never revealed a single living caterpillar or cocoon, although feeding marks can be seen. There is therefor every possibility of a wild food plant existing, and the feeding marks on coconuts may be those of another Zygaenid which is as yet unrecorded on palms. The following palms other than coconut have been observed to be attacked :—

(1) Nipah (*Nipah fruticans*, Thunb.)

(2) Areca (*Areca catechu*, *L.*)

(3) Nibong (*Oncosperma tigillaria*, Hort.)

(4) Sago (*Metroxylon sagu*, Rottb.)

(5) *Calamus* sp.

In Labuan, where areca and sago palms were present in the area attacked, the latter were damaged while the former remained free. Searching other plants in the vicinity of outbreaks for the stages of this insect has invariably yielded negative results except in the case of cocoons which, as mentioned above, will be made anywhere where the full grown caterpillars happen to be.

ECONOMIC STATUS.

Damage to the coconut palm consists of stripping the plant of practically the whole of its foliage. The actual amount of leaf eaten depends on the severity of the attack, and varies from the destruction of the lower leaves only, to almost total defoliation extending to the younger leaves. In general, however, the youngest leaves are not damaged to any appreciable extent, thus enabling the palm to recover from the attack. Leaves which have been partially eaten turn brown and wither, the result being almost the same as if they had been completely eaten. The feeding marks also expose the palm to fungi or other disease agents, which are enabled to penetrate the epidermis. No records are to hand of palms having been killed by *catoxantha*, but the set-back received is very serious, especially in cases where nothing but the mid-ribs of the pinnae are left, when the palm has to wait until it can produce new leaves.

As a result of the serious set-back received there is a considerable loss of crop, both through the young nuts failing to develop and owing to the more mature nuts falling off. The loss of crop has been variously estimated, but owing to differences in the severity of attacks it is difficult to estimate the loss due to what might be called an average outbreak. The loss of a year's crop owing to an attack of average severity is, however, generally considered to be a reasonable estimate. If the number of nuts per acre per annum be taken as 2,500 the loss is equivalent to half a ton of copra per acre. Thus although the palms are not killed, an outbreak on an estate is accompanied by very considerable monetary loss. A number of outbreaks at short intervals of time would mean little less than disaster to a large coconut estate.

PERIODICITY.

Outbreaks do not, fortunately, recur at regular intervals of short duration. Although there are recurrent outbreaks in certain areas they do not, as far as available records show, appear to have any definite periodicity.

Outbreaks have been stated to occur every two, three, four and up to seven years, but no evidence in support of these statements can be found. The actual duration of an outbreak is, however, much more definite, few cases being recorded where more than six broods occurred before the attack was ended. In some instances the attack is of very short duration. On one estate which was visited by the writer in April 1924 a thin infestation was present which was estimated to have started in February. At the time of the visit the caterpillars were heavily parasitised and no further trouble was

experienced. On the other hand some attacks last longer than the sixth brood, and judging from reports from Java some attacks there continue for well over a year.

CHECKS.

In view of the fact that in 'normal' times *Artona catoxantha* is not a pest and that the number of known enemies which help to keep it in check is considerable, the parasites and other factors inimical to its rapid development form the most important aspect of the problem.

As already stated the conditions bringing about an outbreak are at present unknown, but one or two indications suggest that general external conditions play an important part. It is unknown if one or more parasites normally keep *catoxantha* in check, or whether of the large number found during an outbreak, especially in the later stages, many are incidental and not confined to one host in nature. As far as external conditions have been observed, a curious relation appears to exist between the practice of burning fires under the coconut trees and outbreaks. The latter have generally occurred on native small-holdings, and it is a custom among Malays to burn fires at the base of the palm in order to stimulate the production of nuts, a practice which is of very doubtful benefit to the palms and which is not permitted on European-managed estates On those occasions on which outbreaks have occurred on European estates there has always been a previous history of burning under the trees within a comparatively short time. On many coconut estates the dead leaves, husks and other rubbish are spread out and allowed to rot on the ground in order to provide humus. On one estate where this practice is carried out the apparent feeding marks of the caterpillars can always be seen, but there has never been an outbreak. In four cases, however, where rubbish had accumulated to a large extent, it was burnt under the trees, and an outbreak of the pest followed. In one case a curious instance of this relation between outbreaks and burning was observed. An estate had an outbreak in progress which was gradually spreading along a road to another estate a few miles away. On examination a few palms were found to be affected on the latter along the edges of the road, and no signs of the pest could be seen in the adjacent areas on this estate. It was somewhat surprising, therefore, to find five palms infected in the centre of the estate about a mile in a direct line from the nearest point along the road, and to learn that it was at this spot that the garden coolie had burnt a quantity of rubbish. In another instance *catoxantha* appeared on an estate which had become very overgrown with weeds and which was being cleared by areas, the rubbish being burnt under the palms. Burning in this instance was stopped at once and the insect did not appear on any other portion of the estate.

These instances are no proof of the action of heat or smoke on the insects, but are curiously repeated in various outbreaks. The phenomenon would appear to point to one or more of the parasites being particularly susceptible to changed conditions and dying off under the influence of smoke, heat or fumes. That slightly changed

conditions do affect parasites, thus allowing the pest to increase rapidly, is well known, and there are at least some grounds for suggesting that an influence of the above nature is a contributory factor in bringing about outbreaks It is also possible that some stage in the life-history of one or more of the parasites is spent in the rubbish, where they would be killed by burning. It can be confirmed or refuted only by the quantitative study of the actual insects and by an attempt at the experimental production of an outbreak.

Food appears to have no influence on the activities of *catoxantha*, since there is abundant coconut leaf available throughout the year, nor does there seem to be any indication of periodicity in its life history. The factor which influences it must therefore be something in the nature of the fires acting on parasites, or it must be the inter-relation of the parasites and the hyperparasites, or meteorological conditions.

NATURAL ENEMIES.

The natural enemies of the insect attracted attention when it was first noticed. Thus Pratt (6) mentions that 20% of the larvae were parasitised at one place. Richards (11) reports the presence of a Phorid as a parasite, which has, however, not been observed since, and van Heurn (13) says that four species of *Mesostenus* attack the larvae. Roepke (8) noted that one species (afterwards identified as *Mesostenus*, see van Heurn), which he named Parasite "C," also attacked the Tineid, *Acrocercops cramerella*, Sn. Up to the present no parasites have been observed on the eggs, but in the Federated Malay States the writer has taken eight Hymenoptera parasitic on the larvae, while two others, which were single specimens and have been sent away for identification may be the same or different to these. The empty pupal cases of an Hymenopterous ectoparasite have been observed, but the adults have not been taken. This parasite apparently attacks the caterpillar in considerable numbers, twenty to thirty pupae, placed close together on the shrunken larval skin, having been seen on several occasions. In addition to these, three Tachinids have been found, making a total of twelve separate parasites, possibly fourteen. There is also an insect predaceous on the larvae and pupae. One of the Tachinids, the common one which has been investigated, has yielded a total of seven hyperparasites. Only a very small proportion of these insects has been identified, and little is known about them with the exception of the Tachinid ; moreover, in the present state of our knowledge all of them cannot be set down definitely as primary parasites. A rough description of the insects is given below which is sufficient to separate them one from the other for purposes of record.

Goryphus maculipennis, Cam. This is the largest Ichneumonid parasite, being 7 m/m long. The general colour is black, part of the mesothorax and the whole of the metathorax and the petiole of the abdomen being orange yellow. A yellow transverse band on the abdomen. Wings dark coloured in the centre.

Goryphus maculiceps, Cam. Similar to *maculipennis* but smaller, being 5 m/m in length. Wings more shaded. Two yellow transverse bands on the abdomen.

Microgaster sp., No. 576. This Braconid is not common, and the specimens are at present at the British Museum.

Tetrastichus sp., No. 575. Another uncommon parasite, and specimens are at the British Museum. (Chalcididae).

Callimerus sp., No. 1475. This Clerid beetle and its larvae are usually found in small numbers feeding on the pupating larvae and pupae of the moth. Pupal period 10—12 days.

Braconid No. 1085. This is perhaps the commonest Hymenopterous parasite, the small white cocoons which the larva spins on the leaf being generally found throughout the attack. The ovipositor is inserted into the caterpillar during oviposition and the larva emerges when it is full grown, pupation taking place under the shrunken body of the caterpillar. The head and thorax of the adult are black, the abdomen being dark brown with yellow patches on the sides anteriorly. Antennae dark brown. Prothoracic and mesothoracic legs yellow, metathoracic legs brown. Length 3 m/m. Cocoon 3 to 4 m/m long and 1.5 m/m broad.

Chalcidoid No. 1086. Head, thorax and first abdominal segment brown. Eyes pink. Legs and antennae light yellow. Abdomen yellow, banded with light brown. Length 2 to 2.5 m/m.

Chalcidoid No. 1089. A. Head and thorax black, abdomen dark brown. Antennae long, moniliform, with long hairs arising from each segment. Legs brown, becoming lighter towards the distal ends. Abdomen contracted.

Chalcidoid No. 1089. B. Metallic shiny-black in colour. Abdomen pointed. Legs and antennae dark brown but the tibiae light coloured, almost white.

Nos. 1090 and 1358. Only one specimen of each of these has been obtained and they may be the same as one of the others mentioned. Specimens at the British Museum.

Ptychomyia remota Ald. sp. nov. This is the common Tachinid parasite which has only just been named by Dr. J. M. Aldrich of the U.S. National Museum.

Tachinid No. 1574. Two specimens have been taken recently. They differ largely from the common Tachinid, and may be recognised by being entirely black with smoky wings.

Tachinid No. 1685. A single specimen of this insect was taken. It is apparently different to both the other species. Specimen at British Museum.

Relative Importance of Parasites.

In the writer's opinion only one of the above parasites is really important in controlling outbreaks of *Artona catoxantha*, and that is *Ptychomyia remota*. On the other hand one or more of the Hymenopterous parasites may be the controlling insect which, by dying off at intervals, allows the moths to increase without restraint. The greater susceptibility of Hymenopterous insects to changed conditions, and especially of Chalcids, leads one to believe that these parasites play the important part in keeping the moth under control during 'normal' times. When the moth has once broken away, however, the Hymenopterous parasites seem incapable of catching it up and again placing it under control, the Tachinid always having been mainly instrumental in affecting this in all cases seen by the writer. Lewton-Brain (7) however, records that in 1923 an outbreak was finally controlled by an Ichneumonid, but no statistical evidence is available to show to what extent the various Ichneumonids co-operated.

In an outbreak at Lenggong in 1924 no Hymenopterous parasites were found, the Tachinid being the only parasite present. Taking the average parasitisation for 19 counts at different stages in various localities, the Hymenopterous parasites are present to the extent of 1.2% where the Tachinid is present to the extent of 10%. In no case so far has the percentage parasitisation of the Hymenopterous parasites been observed to be over 10%, while 50% and 60% for the Tachinid is not uncommon. At Sungei Ayer Tawar in 1924 the Tachinid parasitised over 45% of the caterpillars in the brood before the attack ceased. No figures are available at present to show the rate of increase in parasitisation and the rate varies enormously from palm to palm and even from leaf to leaf, so that nothing accurate can be given until considerable statistical work has been done. Enough has been said to show, however, that in all the outbreaks observed the Tachinid, *Ptychomyia remota*, is the most important parasite.

PTYCHOMYIA REMOTA, ALD.

On the assumption that it was the most important of the parasites on *Artona catoxantha* this species was studied when material was available.

History.

This Tachinid parasite has long been associated with outbreaks of this pest but has only recently been described from material sent to Dr. L. O. Howard, Chief of the Bureau of Entomology, Washington, who kindly sent it on to Dr. Aldrich (17). *Ptychomyia remota* is nearly related to *P. selecta*, Mg. of Europe.

Distribution.

As far as is known this Tachinid is distributed over the gr
part of the area where *Artona catoxantha* is found, but was not r

in Labuan at the time of the second outbreak, in 1924. An attack was in progress at Lenggong, F.M.S., at this time, and several hundred pupae were collected and taken to Labuan, where they were released as adults. The time taken on the journey to Labuan being only five days it was possible to take the pupae without subjecting them to any special treatment. (Gater (15)).

Life History.

The adults emerge at approximately the same date as the moths of *Artona Catoxantha.* As will be seen later their adult life must be of some length to compensate for their short period of development and the longer period taken by the succeeding brood of their host. In the laboratory, however, the adult life proved to be shorter than was expected, averaging 10 days. This short life was undoubtedly due to improper feeding, a point which will be touched on again in relation to breeding the fly in captivity.

In several instances however, especially among the individuals which laid fertile eggs, the length of the adults' life was prolonged to three weeks, and in one instance a female lived for 27 days. Copulation took place on the same day or on the day following emergence, eggs being laid in from 3 to 8 days after copulation. In one instance the female laid no eggs for thirteen days after copulation. The number of eggs laid by a single female varied greatly, the average being between 25 and 30, but in one case 80 eggs were laid during a period of six days, the number on successive days being as follows:— 8, 26, 21, 5, 11, 6. The male died soon after copulation and repeated copulation was not observed under laboratory conditions. The female generally died a short time, one or two days, after the cessation of egg-laying.

The egg is laid on the dorsal surface of the caterpillar, generally on the thoracic segments immediately behind the head, but may be laid on other portions of the body. As many as 8 eggs have been observed on a single caterpillar, although this is rare, there generally being only one. In cases where several eggs are deposited on the same caterpillar only one larva develops. The egg is longer than broad, convex on the upper and flat on the lower surface, where it is attached to the caterpillar. Parasitised caterpillars are generally found in groups, the fly laying eggs on a number of larvae close together and then going on to another group. There seems to be a reluctance to pick out isolated caterpillars. Hatching takes place two days after the egg is laid, the minute maggot emerging from the lower surface and making its way into the caterpillar through the thinly chitinised area between the segments. The maggot remains within the caterpillar until the latter has spun its cocoon in preparation for the pupal stage. When the cocoon is finished the maggot emerges and pupates, the puparium and the shrunken caterpillar's skin being found under the cocoon even long after the fly has emerged. The period between pupation and emergence is 9 days or the same as that

of the moth. The life history is summarised in the following table:—

LIFE HISTORY OF *PTYCHOMYIA REMOTA*

Period.	Range. Days.	No. of cases observed.	Mean : Days.
Emergence to Copulation -	1 — 2	228	1
Copulation to Oviposition -	3 — 8 (13)	45	4 5
Incubation of egg -	2 — 3	49	2
Larval life -	8 — 16	169	9
Pupal life -	8 — 11 (16)	679	9
Total life of Imago (2) -	5 — 27	228	10*

Figures in brackets denote isolated instances not taken into account in calculating means.

*This figure represents the mean for egg-laying individuals only. Barren females died in one or two days after emergence and have not been included.

Comparing the time taken for the development of the parasite with that of the host it will be seen that the parasite's development is 17 days shorter than that of the moth.

Ptychomyia remota apparently does not as a rule lay eggs until the larvae of its host have attained their third instar, which occurs 14 days before the moth's pupal stage is reached. Eggs may certainly be found in nature on younger caterpillars than those of the third instar, but only rarely and when mixed broods are present. As a rule eggs are not found on any but the caterpillars of the last three instars. From the available figures on the life history of *catoxantha* it is evident that the adult Tachinid must live from the time of its emergence, at approximately the same time as its host, until the latter has laid eggs and the eggs have developed to larvae of the third instar, before eggs are laid. This period is 15 to 20 days. Periods as long as this were not usual in laboratory, but enough instances of an adult life of 20 or more days were observed to justify the conclusion that the normal life is as long as this, and the longer life was especially noticeable in strong egg-layers. The readiness with which the flies copulated soon after emergence indicates that the waiting period is between copulation and laying. This is supported by the figures obtained in the laboratory which show a period of four to five days between copulation and laying, although caterpillars of the right age were present in the cage. The longest time between copulation and laying observed was 13 days, so that no experimental evidence is available to prove that the fertilised females will live for a period of 20 days without laying. But in the laboratory, as stated above, caterpillars of the correct age were available. There was no opportunity of testing the length of life of a fertilised female before laying. In the following figure* the mean life histories of the host and its parasite are

*In the original diagram the stages in the life-history were plotted according to the mean periods, but in the reproduction the proportions have been lost. The figure is, therefor, graphic only, the distances between the vertical lines not representing the actual length of each instar.

placed side by side, the periods during which eggs are most frequently laid by the parasites being shaded. It will be seen that the normal instars on which eggs would be laid are instars III and IV. The actual time of oviposition as shown in this table, calculated on the mean, is just before the moult between instars III & IV, which would mean that the caterpillars would moult and get rid of the egg before it had hatched. This actually occurred in many of the breeding experiments, but in nature oviposition would normally occur earlier in the 3rd or just after the 4th instar had appeared.

PTYCHOMYIA REMOTA	FLY				EGG	LARVA		PUPA
ARTONA CATOXANTHA	MOTH	EGG	INSTAR I	INSTAR II	INSTAR III	INSTAR IV	INSTAR V	PUPA

Alternative Hosts.

At the beginning of an outbreak *Ptychomyia remota* is not present in large numbers, and sometimes cannot be found until after one or two broods have taken place. It was thought that it might not be specialised to one host and that it might merely develop largely during the outbreak owing to the stimulus of an unlimited supply of suitable hosts. In addition to this the fact that the pupae have never been seen in normal times, even in old *catoxantha* areas, suggested that its normal host might be some other caterpillar.

Breeding experiments were therefor undertaken with several caterpillars, and as none was available which was nearly related to *Artona*, caterpillars of other families were used. Eggs were laid freely on the larvae of *Setora nitens*, Wlk. (Limacodidae) *Attacus cynthia*, Dru. (Saturniidae) the Pyralids *Tirathaba* sp. nr. *trichogramma*, Meyr., *Psara bipunctalis*, *F.* and *Maruca testulalis*, Hb., as well as the Banana Skipper, *Erionota thrax*, L. In numerous trials the eggs, however, failed to hatch.

Greater success was obtained with the larvae of *Achaea janata*, L. (Noctuidae) and of *Sylepta derogata*, F. (Pyralidae) In both the latter the life history was completed several times from adult to adult, but only a very small percentage of the eggs laid hatched and completed their development. It has thus been shown that *Ptychomyia remota* will breed on caterpillars differing greatly from its known host, and that it shows a tendency to breed on many more. In releasing parasites for the control of this pest there is every hope, therefor, that the Tachinid will be capable of living in considerable numbers during the times when the host is present in very small numbers only.

Natural Enemies.

During the various experiments conducted with *Ptychomyia remota* a considerable number of hyperparasites was discovered, as

many as seven being probably different while two others may form an addition to the total number.

The hyperparasites are presumably all parasitic on the pupae of the fly and emerge some little time after the adult fly should have emerged. The following rough description may serve to separate them from one another for purposes of record :—

Chalcidoid No. 1335. Dark brown; antennae clubbed and elbowed, seven jointed. 1.2 m/m in length.

Proctotrypid No. 1383. Black with blue and green metallic lustre Wings smoky. Hind tibiae with light coloured keel on outer (dorsal) edges. Ovipositor long. Length 5.5 m/m including ovipositor, 4.1 m/m without.

Proctotrypid No. 1384. Black, metallic. Legs brown but mesothoracic and metathoracic tarsi white proximally. Length 2.5 m/m.

Chalcidoid No. 1497. Head and thorax black, strongly punctate; abdomen black, shiny. Antennae dark brown, moniliform, with hair at each segment. Coxae large. Trochanters, distal ends of femora, tibiae and tarsi yellow. Eyes pink, coarsely granulated. Length 3 3 m/m

Chalcidoid No 1594. Smaller than No. 1335; black with brown legs Funicle of antennae not so long as in No. 1335. Head larger in proportion to rest of the body. Length 0 9 m/m.

Chalcidoid No 1746. Head and thorax black, strongly punctate. Eyes finely granulated. Abdomen shiny black, pointed. Tibiae and tarsi lightening in colour from brown to white distally. Length 1 m/m

Chalcidoid No. 1747. Head and thorax black, strongly punctate. Abdomen black, shiny, segments fringed with short hairs. Hind femora much enlarged. Tegulae, distal ends of femora, tibiae and tarsi light yellow. Length 3.2 m/m.

Hyperparasite No. 1807 is a single specimen now at the British Museum and No. 1808 is similar to but smaller than No. 1746.

The Chalcidoid No. 1594 has been observed to emerge in large numbers from the puparia of its host, the lowest being 13 while the largest number found to have emerged from a single puparium was 82. The average number is 39. There has been no opportunity up to the present for studying the life history of these hyperparasites, but as a rule they do not emerge from the puparium until after the time when the Tachinid should have emerged. This has an important bearing on the technique required for introducing *Ptychomyia remota* into other countries where *catoxantha* or nearly related insects are damaging coconuts, since the introduction of the hyperparasites as well would tend to defeat the usefulness of introducing the Tachinid. As it is, careful records of the probable

time of emergence of the fly should be kept and any which show a tendency to prolong the pupal period should be specially watched and kept in cages which would prevent the minute hyperparasites from escaping. This does not apply to all the hyperparasites, some of which emerge at about the same time as the fly. Recorded instances give the emergence of No. 1497 as 3 days after unattacked flies of the same batch, No. 1594 as six days after and Nos. 1479 and 1508 as 8 and 13 days after respectively.

Resistance to low temperatures.

With a view to transporting *Ptychomyia remota* over long distances keeping the pupae in cold chambers was attempted. In the case of mature pupae, from which the flies were almost due to emerge, the low temperatures seemed to have little effect, the flies emerging in the ordinary way a day or more after having been placed in cold storage. The immature pupae were killed at temperatures of 5°.C. and 10°C. in two weeks. Through the courtesy of Messrs the Singapore Cold Storage Co. Ltd. a batch of pupae was then placed in a chamber where the temperature was kept between 13°.C. and 14°C. but all were again killed in a month.

These experiments were only started at the end of the outbreaks of *catoxantha* in 1924 and so could not be continued. The negative results of treatment by cold thus obtained show that the exact conditions under which this insect may be kept dormant must be ascertained before any attempt is made to transport it over long distances. It is intended to construct a multiple temperature incubator, with which it should be possible to find the optimum temperature for the development of the insect and also the death points at each end of the scale. It is possible that by keeping puparia of the correct age at a temperature slightly below the mean daily temperature in the open air, they may be kept in a dormant condition for long periods.

ENTOMOPHAGOUS FUNGUS.

A fungus, *Botrytis necans*, Massee, attacks the later larval and pupal stages of *Artona catoxantha* apparently causing the death of considerable numbers. It appears to have been first observed by Burkill (9) in 1913 and was described by Massee in the same year. On this occasion and again in 1915 Burkill (10) states that *Botrytis necans* stopped the attack. It is only rarely that a good infestation by this fungus can be seen, but attempts have been made to control outbreaks by hanging up leaves of palms from another area where the pupae were attacked by the fungus, with varying success. In this laboratory pure cultures prepared by the Mycologist (A. Sharples) have been used on healthy caterpillars and pupae with negative results, and spraying caterpillars under natural conditions with the cultures has also given negative results.

The well known difficulty of propagating fungous diseases among insects artificially is probably responsible for the lack of success in these experiments. On the other hand it is not always certain that the fungus can be recognised in the field, and pupae said to be

infected with it have developed to normal adults in this laboratory. During the 1924 outbreak at Sungei Ayer Tawar, where fungus infestation on dead caterpillars was between six and seven per cent, a number of larvae and pupae were taken to the Mycologist, who reported that the fungus present was not *Botrytis necans*, but a collection of saprophytic fungi which are normally found on dead larvae. This indicates that where dead larvae or pupae are found too much reliance may be placed on the fact that they were killed by *Botrytis necans*. The reason of the death of such caterpillars has yet to be sought, however, and two possibilities seem feasible. Either they are first killed by the *Botrytis*, which is then obscured by the growth of other fungi, or the caterpillar had died from the affects of an internal insect parasite which, although it had killed the caterpillar, had not itself been able to develop. In many infestations of *catoxantha* the cocoons are often spun so close to each other that the ends frequently overlap. At Pulo Kuraman it was observed that in many cases the moth had partially emerged inside the cocoon and died, whereas the invariable habit of this insect is to open the cocoon in the pupal stage, the moth emerging after the pupa has half extruded itself from the cocoon. It thus seems probable that a good many die through not being able to emerge from the cocoon, though to what extent this is true appears doubtful.

That considerable success has been attained by spreading the fungus appears from Burkill's (9) report on the outbreak at Singapore. He states that the percentage of parasitisation by Tachinids and Braconids was only 5 per cent in the brood when measures for spreading the fungus were taken Distribution of the fungus was effected by taking portions of coconut leaf whereon caterpillars or pupae had died from the fungous disease and tying them to the leaves of trees where healthy caterpillars were feeding. In the next brood the attack was killed out. According to South (14) an attack at Telok Ayer Tawar in Province Wellesley decreased in severity owing to parasitisation by the fungus. Leaves well infested with caterpillars killed by the fungus were taken from this area to Menglembu, where another attack was in progress, with satisfactory results. As long ago as 1914 Jepson imported cultures of *Botrytis necans* into Fiji in an attempt to control *Levuana iridescens*, and it has been imported on several occasions since. No satisfactory results seem to have been achieved however.

Although the artificial propagation of this fungus by cultures has not met with success in any instance, this method of control should not be dismissed in view of the success said to have been obtained by the distribution of the leaves bearing fungus-infested caterpillars, and the method should be kept in mind as a possible control measure. More work on the fungus is necessary before success can be hoped for by using the cultures, and the fact that success is said to have been obtained by spreading the fungus artificially cannot be taken as evidence that such measures constitute a means of control. The fungus can always be found, and given the proper conditions will spread naturally. In the cases where great mortality from the fungus was observed after measures for its spread had been taken, it is more than

probable that it would have caused just as great a mortality had it not been 'spread' artificially.

METEOROLOGICAL INFLUENCES.

For some time it has been thought that meteorological influences might be responsible for the sudden appearance, and what is more, the sudden disappearance of this pest. A large number of meteorological records has been examined, but during the past it is feared that the records were not sufficiently accurate to enable any definite conclusions to be arrived at. Many of the thermometers were insufficiently graduated, and in addition humidity readings were generally taken in a partially enclosed space with little air circulation, which would produce inaccurate results in a climate such as this.

Further, readings were not taken beyond a whole degree, which makes the humidity records too unreliable to be of any use. Atmometers do not exist as part of the equipment in this country, and even if they did the calibration of the instruments would present difficulties. It is therefor not possible to use any records except those of the mean daily temperature and rainfall, both of doubtful accuracy.

As far as the cessation of an attack is concerned there seems to be some connection with rain and wind, since several attacks have been known to stop without any other reason, as far as could be seen, than the start of rainy and windy weather or the breaking of a monsoon. It is doubtful if rain alone has much affect, but in combination with wind it would kill a large number of larvae. A strong wind beating on the leaves of the palms would tend to make the larvae drop down on their silken threads, and the rain would then wash a large number away or so damage them that they would be unable to reascend the palms. That some definite meteorologic influence is at work appears to be probable from the incidence and cessation of two similar outbreaks which occurred at Pulo Kuraman. The first recorded outbreak occurred there in April 1920 (the caterpillars were first noticed in the middle of the month) and ended suddenly at the beginning of June of the same year. The second outbreak occurred in May (the caterpillars being first noticed on May 5th) and ended on July 25th, 1924. The fact that during the second outbreak the planters were already acquainted with the pest, and would observe it more quickly and accurately tends to place the dates still nearer together. The disappearance in each case corresponded with the breaking of the monsoon. This sensitiveness to wind has been noted on several occasions, and it was most noticeable at Pulo Kuraman where a belt of palms was left untouched to windward of the area. As soon as the monsoon broke the moths and caterpillars rapidly disappeared.

The beginning of an attack might be influenced by a variety of weather conditions, but nothing definite has been found out. The meteorological stations have always been situated at some distance from the area under consideration, and owing to local variations in readings any results must be accepted with caution.

Meteorological Data.

Rainfall (m/m).

Pulo Kuraman.	1919	1920	1923	1924	
January ...	34	298	236	77	Outbreaks occurred in
February ...	47	28	175	68	red in
March ...	221	180	105	258	1920 and 1924.

Batu Gajah.	1921-2	1922-3	1923-4	
December ...	118	470	90	The outbreak occurred
January ...	308	251	241	in 1923 at
February ...	131	272	89	the end of February.

Total Temperatures (°F).

Pulo Kuraman.	1919	1920	1923	1924
January ...	2562	2500	2518	2583
February ...	2289	2283	2200	2399
March ...	2567	2537	2522	2568

Batu Gajah.	1921-2	1922-3	1923-4
December ...	2546	2457	2510
January ...	2532	2476	2582
February ...	2292	2293	2239

The nearest meteorological station to Pulo Kuraman was at Labuan, about 4 miles away. Records were obtained from Batu Gajah, where the station is much nearer the area, and are more representative of the conditions obtaining there. The accompanying table shows the rainfall at Pulo Kuraman (from Labuan records) and at Batu Gajah, and also the total mean daily temperatures for the same areas. In each case the date on which the caterpillars were first noticed was taken and the records used for the three preceding months It is not possible to say definitely whether these months formed the critical periods during which the moth broke away from its parasites, since it is not exactly known at what brood the caterpillars were first seen. If it is assumed that they were not noticed until the second brood then the break-away would be during that period. In January 1920, the year of the first outbreak at Pulo Kuraman, the rainfall was considerably higher than in the preceding year, yet in 1924, the year of the second outbreak, it was lower than in the preceding year. At Batu Gajah the December records for the last outbreak in 1923 show a considerable excess of rainfall over the amount for the preceding and following years.

Charts of the daily mean temperatures for both areas show nothing definite, and the total mean daily temperatures for the months in question appear to shed no further light on the subject in

view of the contradictory figures for two outbreaks in Pulo Kuraman. At Batu Gajah on the other hand the figures are more constant, but the difference in totals is so small that no inference can be drawn from them. One point in the temperature records is, perhaps, worthy of note, and that is the occurrence of "abnormally" low temperatures during the months preceding the outbreaks. Thus during the first two months quoted, 75°F. is recorded twice in Pulo Kuraman in 1920, with a temperature of 73°F. on one occasion, and once in 1924. During 1919 and 1923 the lowest recorded temperature is 76°F. At Batu Gajah in 1922-23 there are 21 records of 75°F., 9 of 74°F. and 1 of 73°F., whereas during the corresponding periods in 1921-22 and 1923-24 there are only 9 records of 75°F. which was the lowest temperature recorded. The mean daily temperatures for the periods being close to 81°F. and varying little, as is natural in Malaya. Further records for Batu Gajah could not be studied because the times at which the pest was first seen could not be ascertained with any degree of accuracy. No conclusion can be arrived at until further accurate records become available.

CONTROL.

Various control measures have been suggested for this insect, none of which can be claimed to have been a great success. One of the commonest practices is to cut off all the more heavily infected leaves and burn them. Apart from the injury done to the palms by this treatment and the danger incurred from the wounds which would be certain to be left if this was done over a large area, and in which the palm weevil (*Rhynchophorus schach*, Oliv.) would be able to lay its eggs, it never stops the attack entirely, and has the disadvantage of killing large numbers of parasites. On one estate where this practice was started as soon as the caterpillars were noticed the attack lasted for a much longer time than usual, and spread over a greater area than had been noticed in other outbreaks. Spraying with lead arsenate and kerosene emulsion has also been advocated, as has also burning under the trees to create a "smudge" and singeing the caterpillars by means of long torches. All these methods have the common disadvantage that they destroy the parasites as well as the pest, and in the case of burning under the palms to produce a "smudge" the smoke seems to have very little effect. In view of the apparent connection between burning under trees and the incidence of an attack, the latter method would also appear to be dangerous. If left to themselves the parasites eventually assume control, and any method, therefor, which kills the parasites is to be condemned. In view of the fact that the principle parasite, *Ptychomyia remota*, rarely oviposits on young caterpillars, it is possible to kill the caterpillars in their early stages without damaging this parasite if spraying is done at the right time. Spraying on coconut trees is very rarely an economic proposition, even if the palms are short. On tall palms it is rarely possible, and the spraying apparatus necessary for use with tall palms is not only not available in Malaya, but would be very difficult to move about on some of the coconut estates. If spraying can be accomplished, a spray containing 2 lbs. of powdered lead arsenate in 100 gallons of water with the addition of one of the common spreading agents, and used as soon as the second instar larvae appear, would stop an

attack if started during the earlier broods. In any case, much good would be done in the later broods of an attack by this method without harming the parasites, all of which would have emerged by the time the second instar had appeared. This method is, however, of small practical value on coconut estates, and would require careful supervision for its correct application. In one case at Batu Gajah the fire engine was obtained by this Department, and a strong jet of pure water played on the leaves bearing the early stage caterpillars. The fire engine was only employed for a short time, but the results were eminently successful, the larvae being beaten down in thousands. They were then collected by children, but the majority seemed unlikely to survive the buffeting they received from the water. The cost of the fire engine worked out at Straits $5 per acre including everything, and on tall trees 4 acres were "sprayed" a day. A powerful pump like a fire engine would not be required in estate practice, but a small power pump capable of throwing a strong jet of water would be a useful means of combatting the pest. On estates this method would, of course, be limited by the facilities available for moving the pump from place to place, and the proximity of a sufficient water supply. The idea of merely knocking the caterpillars off the leaves prompted the use, some time ago, of bamboo poles with which the leaves were agitated. This method is laborious and not as efficient as the jet of water. Banding the palms could be used to prevent the caterpillars reascending the trunks.

The introduction of parasites in large numbers from other areas is a feasible method of shortening the attack, and if parasites are numerous boxes could be employed which release the parasites but retain the moths by means of wire gauze. This necessitates the removal of some leaves, preferably the lowest and most highly infected, care being taken to cover up any wounds made by their removal. This again is not always an entirely feasible method on a large estate owing to the number of boxes which would have to be provided, but if used in the early stages of an attack parasite boxes would materially help in making the attack of short duration.

The introduction of the fungous parasite has been advocated, but as already mentioned in dealing with *Botrytis necans* the results have been so contradictory that no positive recommendations can be made. Tying portions of leaves bearing caterpillars or pupae which have been killed by the fungus to the leaves bearing healthy caterpillars appears to have had some success, but the fungus is always present and will spread naturally if the conditions are suitable.

One method of controlling outbreaks which would be extremely effective would be by breeding large numbers of the parasites and keeping them in a dormant condition ready for release in the infected areas. It has been shown that *Ptychomyia remota* can be bred on two caterpillars differing widely from *Artona catoxantha*, and that it will lay eggs on a great many more. Breeding in the laboratory was not however, successful from the point of view of numbers, owing to the large numbers of infertile eggs which were produced. It is believed that this is entirely due to improper feeding of the adult flies. It has been shown by Glaser (16) and others that food is an important

factor in the oviposition and fertility of *Musca domestica* and other flies, and there seems to be little doubt that the same applies to Tachinids. This must however, form the subject of another investigation, and until more is known about the food factors influencing the fertility of *Ptychomyia remota* breeding it in large numbers is not possible, nor is it certain that they could be kept dormant for long periods. Other caterpillars were tried owing to the difficulty of breeding *A. catoxantha* in capitivity. The life history of the Tachinid on *Achaea janata* and *Sylepta derogata* took from 16 to 26 days with a mean period of nearly 21 days and is thus comparable in time with that of the normal host. The adults were fully developed and no differences could be seen between those which developed on the normal and "artificial" hosts.

Only by a close study of the life-history of the moth and the relation of its various parasites to it, and of the influence of the hyperparasites, will any satisfactory control measures be devised. On very large areas dusting by aeroplane is a feasible control method if done in the early stages, but such methods are too advanced for use in this country at the present time. In the imperfect state of our knowledge the following recommendations are made:--

1. No burning of rubbish or other material under the coconut palms to form any part of estate practice.

2. Spraying, if possible, as soon as the second instar caterpillars have appeared, to be stopped as soon as the third instars have appeared.

3. The use of a strong jet of water supplemented by banding during the same period as for spraying

4. No action to be taken which will kill the parasites, such as cutting and burning or late spraying.

5. Release of parasites without the moths by the use of parasite boxes. The lower leaves, which would be the most heavily infected, could be used for this purpose.

SUMMARY.

1. *Artona* (*Brachartona*) *catoxantha*, is an important pest of coconuts in Malaya and surrounding countries. It appears at uncertain intervals in enormous numbers.

2. An attack of moderate severity results in the loss of about a year's crop. but the palms are not killed outright.

3. The life history takes 5 to 6 weeks. Eggs are laid singly on the underside of the pinnae. The larvae feed on the epidermis of the underside of the leaves in straight lines, giving typical feeding marks. The later stages may eat the edge of the leaves. Pupation takes place on the leaf in flat oval-shaped cocoons.

4. Attacks have always been controlled by parasites, five to six broods taking place before this is accomplished.

5. Nine Hymenopterous parasites, three Tachinid parasites, a predaceous Clerid and an entomophagous fungus have been discovered on the larvae.

6. The most important parasite appears to be the Tachinid, *Ptychomyia remota.* The life history of this parasite takes 20 days and it is attacked by 7 hyperparasites.

7. *Ptychomyia remota* has been bred on the caterpillars of *Achaea janata* and *Sylepta derogata.* Efforts at keeping the pupae in cold storage have so far failed.

8. No definite meteorological influences can be found, but the cessation of attacks where the parasites are not abundant has coincided with the breaking of a monsoon. It is thought that strong winds are detrimental to the caterpillars.

9. There appears to be a connection between the occurrence of outbreaks of the pest and the practice of burning rubbish under the palms.

10. *Ptychomyia remota* has been introduced into an area for the control of this pest, but breeding it in large numbers has so far not been successful.

11. Control measures suggested are the cessation of burning under the palms as part of estate practice; the use of a lead arsenate spray, or a strong jet of water supplemented by banding during the first, and early stages of the second, instar; and the release of parasites by the use of parasite boxes.

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ILLUSTRATIONS.

(About natural size)

The accompanying illustrations are included as a guide to planters and others who may not be acquainted with the different stages of *Artona catoxantha*. No illustrations of this insect have been published in Malaya, the only available ones being in Dutch publications which are not always readily available.

Fig. 1. Larvae.

Fig. 2. Pupae, a. Newly formed.
b. Just before emergence.

Fig. 3. Cocoons on leaf.

Fig. 4. Cocoons showing empty pupal cases projecting.

Fig. 5. Adult. a. Male.
b. Female.

Fig. 6. Attitude of moths while resting.

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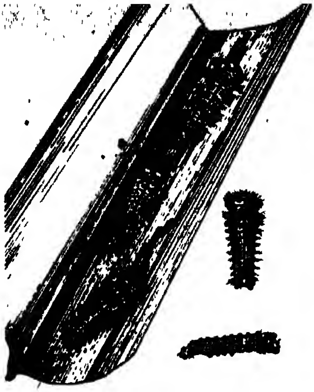


Fig: 1

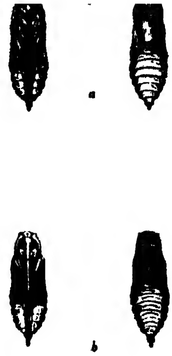
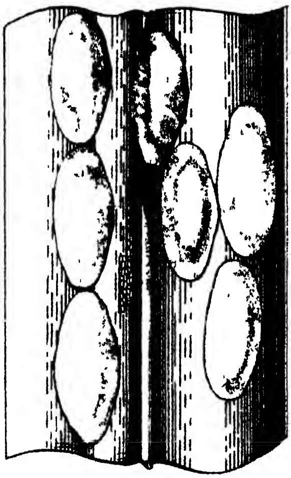


Fig: 2



Fig· 3

Fig: 4

Fig: 5

Fig. 6

FIBRE INVESTIGATIONS.

IN connection with investigations on fibres, particularly Sisal hemp, Pineapple fibre and fibres from plants allied or similar to the Arghan Fibre plant, the following reports from the Imperial Institute and from various dealers in Australia on fibres prepared at the Department of Agriculture are published for information.

SISAL HEMP.

An article on Sisal hemp was published in this Journal Vol. XII, No. 11, 1924.

A sample of the fibre prepared at the Department of Agriculture from plants grown at the Experimental Plantation, Kuala Lumpur (planted 1914 and cut 1924) was submitted to the Imperial Institute and the following report on the sample has been received :—

" The sample consisted of a bundle of coarse, lustrous, cream-
" coloured fibre well cleaned and prepared. The staple varied
" from 2 feet 10 inches to 4 feet 3 inches with an average of
" 3 feet 6 inches. The strength is described as good.

Results of Examination :—An investigation of the fibre yielded the following results.

		Sample examined at Imperial Institute.		Sample examined at Department of Agriculture.
Moisture	-	11.8 per cent.		13.3 per cent.
Ash	-	0 5 ,,	on dry fibre.	0.9 ,,
Hydrolysis "A" Loss	-	10.4 ,,	,,	12.0 ,,
,, "B" ,,	-	12 4 ,,	,,	14 0 ,,
Acid Purification	-	1.3 ,,	,,	1.3 ,,
Water washing	-	1.1 ,,	,,	Trace ,,
Cellulose	-	77.1 ,,	,,	78.2 ,,

The results indicate that the fibre is of excellent quality, especially as it suffers comparatively small losses on treatment with dilute alkali (hydrolysis) and acid treatment and contains a high proportion of cellulose.

Commercial Valuation :--Consignments of fibre of similar quality would be readily saleable in London at a price equivalent to the best East African grades, which are quoted (Nov. 1924) at £50 per ton.

(Remarks :--The plants from which this fibre was obtained had not been cut regularly and were about 10 years old. The average weight of a leaf was 0.8 lb., length 8½ feet and breadth 4 inches. The yield of fibre on the fresh green leaf was 5 per cent. B.J.E)

Report from Australia.

The following reports from various dealers in Australia to whom samples of Sisal hemp prepared at the Department of Agriculture were sent are also of interest.

Firm A. Melbourne: —The sample is of fair length and fair quality, but the colour is not equal to Java "A" Sisal. It is a commercial article and at the moment we value it at from £45 to £48 per ton *c.i.f.*

Firm B. Melbourne:—The Sisal sent is only fair quality, being rather short side and lacking in lustre and sheen. Commercially this fibre is not equal to Java Sisal. On today's market the value would be about £48 per ton at Melbourne.

Firm C. Melbourne:—The Sisal is not up to the Java Sisal which we import. The length is certainly good but in its present state we would not call it a high grade fibre on account of it not being cleaned properly. It is used largely in Australia for the manufacture of cords and also for the Fibre Plaster Sheets manufactured. No value was quoted, but the firm asked for quotations.

Firm D. Perth: —The sample is not as good quality as the Java Sisal owing to (1) its harshness in texture. (2) poorer colour. The length of the fibre is fairly good and sufficiently long for our purposes. The value of the fibre is about £37—£38 per ton *c.i.f.*, Freemantle. The fibre should be pressed in tightly packed bales of about 5 cwt. each.

Firm E. Perth:—The quality is very fair. We understand this hemp is chemically bleached, your sample is not as evenly bleached as we would like. There must not be any green strands left in the stuff for our work (Note: —None of the samples had been chemically bleached. In Java, the fibre is sun-bleached and it is probable that the washing, brushing and sun bleaching of these samples had not been carried out sufficiently B.J.E.)

The price of "A" quality hemp fluctuates from £35 to £45 per ton *f.o.b.* Freemantle.

Firm F. Brunswick:— It is an excellent fibre. The value is about £48 —£49 per ton *c i.f.*

It will be noted that the opinions expressed by the Australian dealers are somewhat varied, although the majority are of opinion that the samples are not up to the standard of the best Java Sisal. This however is probably due to the preparation, which can be improved by the use of more efficient machinery, further washing and sun drying.

Pineapple Fibre.

The sample of pineapple fibre reported on by the Imperial Intitutes was extracted from the leaves of plants grown by Mr. Goh Hock Huat

at Klang for fruit purposes. The leaves were cut from the plants after fruiting. The average weight of a leaf was $2\frac{1}{4}$ ozs., length 4 feet and breadth 1 inch. The fresh green leaves yield about 1 per cent. of dry cleaned fibre.

The sample consisted of a bundle of a fine, rather harsh, lustrous, pale cream-coloured fibre which was well cleaned on the whole but contained a few hard "runners." The strength is described as very good. The staple varied from 2 feet 6 inches to 4 feet 6 inches, with an average of 3 feet 6 inches.

Results of Examination:—The following results were obtained on investigation of the sample.

	Sample examined at Imperial Institute.		Sample examined at Dept. of Agric.
Moisture -	10.7 per cent.		9.7 per cent.
Ash -	0.7 ,,	on dry fibre	0.8 ,,
Hydrolysis "A" Loss -	13.1 ,,	,,	14.7 ,,
,, "B" ,, -	17.9 ,,	,,	17.0 ,,
Acid purification ,, -	2.9 ,,	,,	2.2 ,,
Water washing ,, -	3.3 ,,	,,	0.9 ,,
Cellulose ,, -	78.6 ,,	,,	79.0 ,,

The results indicate that the sample is of good quality and fairly well prepared, but contains a slight excess of gummy matter.

Commercial valuation:—Pineapple fibre, owing to the difficulty of extraction, is not offered to any extent on the London market, but fibre of the quality of the sample would probably be saleable at about £50 per ton (Nov. 1924) if offered in commercial quantities.

(NOTE:—The Chemical Division has recently prepared about 3 cwt. of pineapple fibre from leaves obtained from plants growing at the Government Plantation Serdang, for despatch to the Belfast Rope-works and the Textile Department of the Municipal College of Technology, Belfast, who have kindly offered to prepare and spin the fibre and convert and dye the yarn. A report on the results will be published later. B. J. E.)

CARAGUATA FIBRE (BROMELIA ARGENTINA).

A sample of fibre was extracted from leaves of the Caraguata fibre plants grown at the Government Plantation, Serdang.

The plants from which the fibre was obtained were planted in March 1923 and the leaves cut in October, 1924.

The average weight of a leaf was 2.2 ozs, the length $3\frac{1}{2}$ feet and breadth 2 inches. Yield of fibre on fresh leaf: 1.5 per cent.

Results of Examination :—The following results were obtained on examination of the cleaned fibre:

	Sample examined at the Dept. of Agric.		Sample examined at the Imperial Institute.	
Moisture	- 10.87 per cent.		10.9 per cent.	
Ash	- 0.21	„ on dry sample.	0.4	„
Water purification loss	- 0.57	„ „	0.6	„
Acid „ „	- 0.69	„ „	1.8	„
Hydrolysis "A" „	- 16.98	„ „	16.0	„
„ "B" „	- 23.66	„ „	23.0	„
Cellulose	- 68.08	„ „	70.9	„

The following additional observations are included in the Imperial Institute report :—

The sample consisted of a white, fine, lustrous fibre, which was on the whole well cleaned and prepared, although a small amount of parenchymatous matter was still adhering in places. The fibre was strong and had a length of staple ranging from 24 to 44 inches, but mostly about 30 inches. The ultimate fibres measured from 1 to 3.5 mms in length with an average of 2.3 mms and 0 005 to 0.018 mms in diameter with an average of 0.012 mms.

The results of the two examinations are in close agreement and indicate the presence of a rather large amount of gummy matter, which is removed on boiling for five minutes with hot dilute alkali (hydrolysis A).

The true fibre substance appears to be fairly resistant to the action of alkali, as a further loss of only 7 per cent occurs after boiling for 55 minutes longer (hydrolysis B).

[NOTE :—The resistance however is certainly not as good as in the case of sisal hemp and pineapple fibre, in which the extra loss on "hydrolysis B" is only 2 and 4 per cent respectively. B.J.E.]

After allowing for the gummy matter, the percentage of cellulose is satisfactory.

Commercial Value :—The fibre was described by merchants in London, to whom it was submitted, as a soft fibre of rather dingy colour and short staple, well cleaned, of good strength and readily saleable in London at £36—£37 per ton (January, 1925).

The fibre is not suitable for spinning as a substitute for flax or other soft fibre of similar class but would find a ready market as a cordage fibre in competition with "Maguey" fibre (Agave Cantala-

=Sisal) and Indian "Aloe" fibre. A fibre of greater and more regular length is however desirable (It is probable that the leaves from which the fibre was extracted were immature B. J. E.)

Cultivation and Growth :—The following notes on the cultivation and growth of the plants have been prepared by Mr. J. N. Milsum, Ag. Agriculturist, S.S. & F.M.S.

The suckers were received from the Argentine in October 1923 and the plants, which were established in the nurseries, made rapid growth and were planted in the field without shade in March 1923. The planting distance subsequently adopted was 10 feet x 5 feet. The plants soon produced suckers which were used for further planting.

In May 1924 the maximum height of the original plants was 5 feet and average length of leaf 3½ feet, number of leaves per plant was 80, breadth of leaf 2½ inches and weight of green leaf 3 ozs. The plant grows well on ordinary soil and commences to sucker when a year old. It grows well in full sunshine. In this respect it differs from the Arghan Fibre plant (Bromelia Magdalenae).

The leaves are difficult to handle for fibre extraction owing to the presence of strong thorns along the edges.

The original plants, among other related fibre plants, were obtained from the Argentino, where they are indigenous, in order to compare the plants and the fibre with the Arghan Fibre plant introduced into Malaya a few years ago, probably from South America.

References D.A. 1136/21, 518/24, and 1061/24. A.C. 153/24 and 198/24.

B. J. E.

Convener. Fibre Committee.

Received for publication 20th April 1925.

LONDON MARKET PRICE LIST, 1st QUARTER 1925.

Oil Seeds.

Castor (Bombay)	-	£26.7.6 to £23	per ton.
Copra (Ceylon)	-	£31 to £30.10 0	,,
Do. (Straits)	-	£30.5 to £29.5	,,
Cotton (Egyptian)	-	£13.7.6 to £18.2.6	,,
Do (Bombay)	-	£10.15.0 to £10.12.6	,,
Croton	-	27/6 to 32/6	per cwt.
Desiccated Coconut (fine)	-	38/6 to 38/-	,,
Do. do. (medium)	-	,,	,,
Do. do. (coarse)	-	43/-	,,
Gingelly (Chinese)	-	£27.12.6 to £25.5	per ton.
Groundnuts (Gambia, undecorticated)	-	£18 to £17.2.6	,,
Do. (Chinese, decorticated)	-	£23.15 to £22.7.6	,,
Linseed (Bombay)	-	£24 to £25 5	,,
Do. (Plate)	-	£21 to £22.7.6	,,
Palm Kernels (West Africa)	-	£22.7.6 to £21.2.6	,,

Oils.

Castor (Madras)	-	61/6 to 71/-	per cwt.
Do. (Pharmaceutical)	-	78/- to 66/-	,,
Do. (1st pressing)	-	73/- to 68/-	,,
Do. (2nd pressing)	-	71/- to 58/-	,,
Coconut (Cochin)	-	62/6 to 60/-	,,
Do (Ceylon)	-	47/6	,,
Cotton seed (Egytian, crude)		46/6 to 45/-	,,
Do. (Bombay)	-	44/6 to 43/-	,,
Groundnut (Oriental, crude)	-	55/6 to 50/-	,,
Do. (English)	-	56/ to 49/6	,,
Linseed (Calcutta)	-	46/- to 48/-	,,
Do. (Plate)	-	45 - to 47/6	,,
Palm (Lagos)	-	£39/10 to £42 15	per ton.
Palm (Sumatra)	-	£36.2 6 to £36 5	per ton.
Palm Kernel	-	41/-	,,

Oil Cakes.

Coconut	-	£11 5.0 to £12 10	per ton.
Cotton (Egyptian seed)	-	£8 15 to £8.2.6	,,
Do (Bombay seed)	-	£8.5 to £7	,,
Groundnut (decorticated)	-	£13 to £11	,,
Linseed	-	£13.2.6 to £11	,,
Palm kernel	-	£8.10 to £8	,,

Essential Oils.

Cajeput	-	3/3 to 2/11	per lb.
Camphor (Chinese, crude)	-	2/4½	,,
Do (Japanese refined)	-	2/7 to 2/8	,,
Do. (oil)	-	59/6 to 61/-	per cwt.

Essential Oils—*contd.*

Cinnamon (Ceylon leaf)	- 4¼d. to 5d.	per oz.
Citronella (Ceylon)	- 3/- to 2/1!	per lb.
Do. (Java)	- 5/9 to 4/9	,,
Clove	- 7/3 to 7/9	,,
Lemon grass (Cochin)	- 4/10 to 5/1	,,
Lime (West Indian, expressed)	- 12/6 to 15/-	,,
Do. (do. distilled)	- 6/6 to 7/10	,,
Patchouli (Penang)	- 15/ to 15/9	,,
Vetiver (Bourbon)	- 48/- to 50/-	,,

Spices.

Capsicums (East Indian)	- 10/- 15/-	per cwt.
Do. (Nyassaland)	- 60/- to 70/-	,,
Chillies (Zanzibar)	- 35/- to 40/-	,,
Do. (Nyassaland)	- 50/- to 60/-	,,
Do. (Japan)	- 119/- to 130/-	,,
Cinnamon (Ceylon)	- 1/7 to 1/4 per lb. according to quality.	
Cloves (Zanzibar)	- 1/- to 1/1	per lb.
Cloves (Penang)	- 2/6 to 3/-	,,
Ginger (Japan)	- 100/-	per cwt.
Do. (Jamaica)	120/- to 150/-	,,
Mace (Bombay and Penang)	- 3/- to 3/9 per lb. according to quality.	
Nutmegs (Singapore and Penang)		
110's	- 2/2 to 2/-	per lb.
80's	- 2/5 to 2/4	,,
64's -57's	- 2/6 to 2/8	,,
Pepper (Singapore, black)	- 5d. to 5½d.	,,
Do. (do. white)	- 9d to 9½d.	,,
Tumeric (Bengal)	- 80/- per cwt. nom	

Drugs.

Cinchona Bark	- According to analysis Market steady.
Cocaine (hydrochloride)	- 22/6 to 24/6 per oz.
Ipecacuanha (Rio)	- 7/9 to 8/- per lb.

Natural Dyestuffs and Extracts.

Annatto (seed)	- 10d. to 1/-per lb. Nom.	
Gambier (block)	- 70/-	per cwt.
Do. (cubes)	- 120/- 95/-	,,

Gums & Resins.

Damar (Singapore)	- 30/- to 150/- per cwt.		
Do. (Batavia)	- 120/- to 160/- ,,		
Dragon's Blood (reeds)	- £18 to £25	,,	Nom.
Do. (lump)	- £6 to £15	,,	Nom.

Gums & Resins—*contd.*

Guttapercha (genuine)	-	2/9 to 6/-	per lb.
Do. (Sarawak)	-	3/- to 4/-	,,
Do. (Siak, reboiled)	-	10d.	,,
Jelutong	-	£30 to £60 per ton Pressed 9d. per lb.	

Fibres.

Cotton (American G. to Mid.)	-	11.57d. to 13.27d.	per lb.
Do. (Egyptian Sakellaridis, G.P. to fine)	-	29.40d. to 32.90d.	,,
Hemp (Manila, "J" grade)	-	£56 10	per ton.
Do. (Mauritius)	-	£45.10 to £48	,,
Do. (New Zealand)	-	£41 to £44	,,
Do. (Sisal)	-	£30 to £53	,,
Kapok (Indian)	-	11¼ to 11d.	per lb.
Do. (Java)	-	1/2¼ to 1/2½	,,

Foodstuffs.

Cocoa (Ceylon, plantation)	-	80/- to 120/-	per cwt.
Coffee (Malay Plantation)	-	110/- to 140/-	,,
Do. (do. Liberian)	-	105/- to 120/-	,,
Sago (pearl)	-	28/-	,,
Do. (flour)	-	17/6 to 18/6	,,
Sugar (Java, white)	-	30/9 per cwt.	
Tapioca (Penang, flake)	-	3½d. to 4d. per lb.	
Do. (Penang, flour)	-	18/- to 22/- per cwt.	

Chemicals.

Acetic acid (glacial)	-	£68	per ton.
Do. (80% comml.)	-	£41	,,
Acetone	-	£75	,,
Ammonia (.880)	-	£24	,,
Calcium acetate (grey)	-	£15 to £15.10	
Citric Acid	-	1/4½ per lb.	
Formic Acid (85%)	-	£49	per ton.
Formalin (40% vol.)	-	£44	,,
Lime Juice (concentrated)	-	£18.15 per ton Nom. No sales.	
Sodium bisulphite (60—62%)	-	£17 to £18	per ton.
Sodium Sulphite (anhydrous)	-	£27.10	,,
Wood Creosote (unrefined)	-	2/9 per gallon	

Oil Seeds, Oils, and Oil Cakes.—The market for oil seeds was strong towards the end of 1924, but had eased off by the February returns available. The price of Palm kernels (West African) started firm but became quiet in January. Palm kernel oil cake remained normal with a scarcity of stock. Oil and oil cakes have followed the trend of oil seeds. Groundnut, and ground nut cake are perhaps the exceptions, the market remaining steady, although on rather a lower level.

Essential Oils, Spices and Drugs.—The essential oil market calls for better comment. Prices have remained at round the same level ruling three months ago.

Natural Dyestuffs and Extracts.—Prices remain normal. The Chemist and Druggist, February 28, 1925 contains the following note on Annatto seed:

> "The new food preservative proposals issued by the Ministry of Health for discussion prohibit the use of gamboge and a number of coal-tar dyes giving a yellow colour. As this also refers to foods imported into this country (England), it is anticipated that Annatto seed, which is at present used only in small quantities, will find a greater outlet, this being one of the very few yellow dyes upon which a veto is not placed. Forward business has been quiet, and prices quoted are only normal. For fair Madras and Jamaca on the spot, 1924 crop, 1/- to 1/3 per lb. is asked."

In view of the fact that annatto grows freely in this country, this statement is of peculiar interest locally, for should the Ministry of Health proposals be accepted, it is bound to stimulate the annatto market.

Cotton and Fibres.—The forecast of the cotton crop for 1924—1925 from countries which supply an aggregate of about 80% of the world's production shews that the yield for the current season furnishes an increase of 27% as compared with last year's outturn. The American crop will supply the largest total for nine years.

Messrs. Ide and Christie report (January 15) that the Manila Hemp Market has ruled dull and uninteresting, with very little business passing. The most noticeable feature has been the continued active demand from the United States for the fine grades of hemp for which a considerable advance is recorded.

This Market Price List is based on the quotations contained in the following periodicals and lists:

Lewis and Peat Ltd. Monthly Prices Current (Baltic Dept.) (9-12-24, 12-2-25).

Lewis and Peat Ltd. Monthly Prices Current (Baltic Dept.) (10-12-24, 4-2-25).

Lewis and Peat Ltd. West Indian, Central America and Bazilian Monthly market report 10-12-25, 26-1-25.

British Trade Journal, January, February, 1925.

Fertilizers and Feeding Stuffs Journal, December, 1924, January, February, 1925 issues.

Chemist and Druggist, January and February, 1925 issues.

Chemistry and Industry, January and February, 1925 issues.

Chemical Age, January and February, 1925 issues.

Received for publication 2nd April, 1925.

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; and the Malay States Information Agency, 88, Cannon Street, E.C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV	(1913-16) VIII & IX (1920-21)		price	$5.00 per volume.
Vol. V	(1917)	Nos. 1, 2, 3, 5 & 6	,,	2.50 per set.
,, VI	(1918)	,, 1, 7, 8 & 12	,,	2.00 ,,
,, VII	(1919)	,, 2—6	,,	4.50 ,,

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

Vol. X (1922)	Price $5.00 per volume.
,, XI (1923)	Price $5.00 per volume or 50 cents per single number.

Back numbers of Vols. I—X will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased at the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co.

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, Government Entomologist, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher.
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, Government Entomologist, 1910, reprint 1916, 20 cts. (Out of Print.)
4. A Lepidopterous Pest of Coconuts, *Brachartona catoxantha, Hamps*, by H. C. Pratt, 1909.
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909.
6. Preliminary note on a Branch and Stem Disease of *Hevea Brasilienisis*, by W. J. Gallagher, 1909.
7. Coffea Robusta, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910.
9. Die-Back Fungus of Para Rubber and of Cacao, by K. Bancroft, 1911.
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher, 1910.
11. Coconut Cultivation, by L. C. Brown, 1911.
12. Padi Cultivation in Krian, by H. C. Pratt, 1911.
13. A Root Disease of Para Rubber, *Fomes Semitostus*, by K. Bancroft, Assistant Mycologist 1912, 20 cts.

C = Cancelled

THE

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PRELIMINARY NOTES ON MANILA HEMP.

By R. O. Bishop & E. A. Curtler.

THE object of this article is to place on record the results which have been obtained in the Department of Agriculture during the examination of some fibres taken from plants of *Musa textilis* supplied from the Experimental Plantation, Serdang and the Department of Agriculture, Sarawak; also to compare the above mentioned results with those obtained by making similar tests on standard samples of Abaca Fibre received from the Bureau of Agriculture, Phillippine Islands.

It is not possible at present to give any information with regard to the yield of Manila Hemp per acre under Malayan conditions or other factors essential to the economics of the crop, but investigations are being continued in the Department of Agriculture and further results will enable conclusions to be drawn as to the suitability of Malayan conditions for the profitable cultivation of Musa textilis.

It is intended here to give a brief survey of the information that is available as to the Abaca Fibre industry in the Philippine Islands together with the results which have been obtained at the Department of Agriculture from the examination of samples of fibre prepared under standard conditions. The experience gained from experimental cultivations in British North Borneo is also available for record and a summary of the results is set forth in comparison with the results already obtained at the Government Experimental Plantation, Serdang.

Abaca Fibre in the Philippine Islands.

The term "Manila Hemp" or "Manila" is no longer used in the Philippines, the Spanish-Philippino term "Abaca" or "Abaca Fibre" is always employed there and from correspondence with the United States Department of Agriculture it appears that the term "Abaca" is a more accurate designation of the product.

The Director of Agriculture, Bureau of Agriculture, Philippine Islands in his Annual report for 1923 when writing of Abaca stated

"This crop, the fibre par excellence in the world, which declined considerably in its production after the signing of the Armistice because of a glutted market, was restored this year to its former rank, the largest production ever known in the Islands having been recorded. During the decade prior to the signing of the Armistice the annual production of Abaca was 2,468,090 piculs and the largest crop known was for 1911, which was 2,717,460 piculs. This year the production was 2,986.386 piculs, which was 21% larger than the 10 year average of 1910-19, 10% larger than the record crop for 1911 and twice as much as last year's crop.

"This excellent result obtained by the farmers despite their difficulties in securing sufficient labour was realised because of the big demands this year for abaca fibre in the world's markets and a proportional rise in the prices commanded, from *P=10.41 per picul last year to 18 16 this year. This price was P 1.83 higher than that normally prevailing before the war."

Climate and Soil.—Abaca requires an evenly distributed rainfall, a tropical climate and the absence of heavy winds. The plant is a native of the tropics, but it is stated that excessive heat is detrimental to the quality of the fibre, possibly owing to increased transpiration. The plant has been found to flourish up to a height of 3000 ft. above sea level. On account of the large leaf surface the crop cannot be successfully cultivated in a situation subject to heavy winds, for many of the plants would be blown down, especially in young areas, where the intervals between the plants are comparatively great.

The two main soil conditions required are a plentiful supply of natural food material and good drainage.

The soil must be fertile since it is the normal practice to plant an area with abaca fibre and to harvest that area for approximately fifteen years without any manure or rotation of crops. This is a heavy drain on the soil with a crop like abaca, which involves the removal of a large amount of organic matter when the stems are taken to the factory for preparation, especially when one realises that the stools are only 8—10 ft. apart and that each stool may yield as many as three stems every four months.

The second point with regard to drainage will be discussed in connection with results obtained at the Government Experimental Plantation, Serdang.

The type of soil is important as it has been shown that *Musa textilis* is a surface feeder and that roots growing in a heavy or close grained soil do not develop so well as those growing in a more open soil From the experience gained by the College of Agriculture, Los Banos, it is shown that a deep sandy loam is the most desirable, but some varities of abaca are known which are capable of producing satisfactory crops under heavier soil conditions. The "Tangongon"

* Straits Currency $1 equivalent to P 1.4 Manila currency.

variety of abaca fibre grows in a heavy clay soil and is resistant to drought, and it appears, from the literature on the subject, that systematic breeding would enable the production of varieties suitable for an extensive range of soil and rainfall.

Botanical.—Manila Hemp or Abaca fibre is obtained from *Musa textilis*, which belongs to the Natural Order Scitamineae. All species of Musa, i.e. the wild and cultivated bananas, contain a fibre but only the fibre from *M. textilis* has a commercial value, the other species yield a comparatively low proportion of an inferior fibre*

The plant is a tree-like herb, reaching under ideal conditions an overall height of 33 ft., the part commonly referred to as the stem is really a pseudo-stem consisting originally of the bases of the closely packed leaf sheaths which grow from the fleshy root stock, it is cylindrical, and when mature up to 20 ft. in length.

The leaves are oblong, somewhat pointed at the ends, rather smaller and firmer than other species of Musa, a bright green on the upper side and somewhat glabrous below. When the plant is nearing maturity the flowering stalk is pushed up through the centre of the leaf sheaths from the root. The flowers are first enclosed in a cone, each cluster of flowers being covered by a firm brownish bract. The first bracts which open contain the female flowers, from which the fruits are formed, the outer bracts only contain male flowers. The fruit is green, about two and a half inches long and up to one inch in diameter, the section of which is roughly a triangle with convex sides. The seeds are black, about 1/6 inch in diameter, somewhat flattened. The fruits are not edible. The plant may be propagated from seed, suckers or by division of the root stock.

Planting suckers is the method usually employed in establishing *Musa textilis*. At the base of the parent, suckers are freely produced and they can be removed without interfering with the further growth of the plant. The method next in favour is that of dividing the root-stock, the disadvantage being that the entire parent, must be removed and consequently the method is not economical unless it is desired to replant an area.

Propagation by seed is a slow and expensive method only of interest in connection with the breeding of new varieties or if it is desired to increase the number of plants by every available means.

Harvesting.— The first stems should be ready for harvesting, between 1¾--2 years after planting, by which time the stool should consist of from twelve to twenty-five stems.

The stems should be cut just before or as soon as the flowering stalk appears, and as close to the ground as possible. Care must be

*Samples of "Wild Pisang" (*Musa sp.*) from Frasers Hill, Pahang, yield approximately one per cent of a weak fibre. Samples from Carey Island, Selangor, had a somewhat better tensile strength, the yield being unknown. In both cases the colour was poor.

taken to see that a sloping cut is made, otherwise rain will collect on the cut surface and cause rot to start, which will injure the root stock and the remaining plants in the stool.

Method of preparation.—In order to obtain the best results, it is imperative that the fibre should be extracted as soon as possible after the plants have been cut.

The first process in stripping consists of removing from the back of the outer sheath, with the aid of sharp bone (called in the Philippines a "*Locnit*") two to four strips of fibrous material 2 or 3 inches wide, each strip being the whole length of the sheath. The remaining part of the sheath is then removed and each successive sheath is dealt with until the central flowering stalk is reached. These strips are usually separated into two grades, according to colour, to facilitate the final grading of the fibre.

This work is usually done in the field to avoid the transport of large quantities of material to the central stripping shed. In the central stripping shed the pulpy part of the strips is removed from the fibre with the aid of a simple machine called "*Panguijan*" or "*Jayutan*". This machine consists of a log of convenient height, on top of which is fastened a block of smooth hard wood. Above this block a blunt knife with a handle is fastened by means of a pin at the base of the blade. The end of the handle is connected to a bamboo above and a foot treadle below, by means of pieces of rotan. The bamboo is so arranged that it forms a spring which keeps the knife firmly down on the block of hard wood when the machine is in use. The foot treadle is used by the operator to lift the knife from the block when he wishes to insert a fresh strip of leaf-sheath. The amount of pressure exerted on the knife is adjusted by means of altering the length of the rotan from the knife handle to the bamboo.

The method of extraction is for the operator to raise the knife, by means of the foot treadle, and then place one or more strips of leaf-sheath under the knife, the foot is then taken off the treadle and the knife is pressed down on the block by the action of the bamboo spring. The strip is then pulled through by the operator and this removes all the pulp from the fibres; the strip is then reversed and the pulp from the part previously held in the operator's hand is removed as before.

The fibre thus produced is sorted into two grades and then hung on poles in the sun to dry.

Although the above operations appear simple, care must be taken to see that they are properly performed as the way in which this work is done controls the quality of the fibre produced. If the knife edge is not smooth or the pressure is insufficient, some of the pulp will be left on the fibres; if the pressure is excessive an undue amount of fibre will be wasted and the operator will lose that proportion of his day's production.

Examination of Manila Hemp.—The Abaca fibre grown in the Philippine Islands is subjected to an official grading before being

placed on the market. The standards adopted serve as criteria for classfying the whole of the word's supply of Manila Hemp, thus it is relevant to record here the designations of grades and types established by the Philippine Islands Government Grading Stations.

The characteristics of a fibre which affect its grade are ;—

Tensile strength.
Colour.
Extent of cleaning.
Texture.
Length.

Tensile Strength.—This is a basic quality and any fibre must possess an average normal breaking strength in order that it may be graded to any of the established standards, otherwise the fibre will be graded as "damaged," irrespective of its colour or cleaning.

Colour.—The tensile strength of a fibre being good the practical grading of a "lot" or "parcel" will be based on its colour. The colour ranges from brown or purple to white. Classification is made by comparison with standards. The superior grades are practically milk white. The fibre graded as "Current," which comprises the bulk of the world's supply, is white with a few traces of light brown.

Extent of Cleaning.—The method of cleaning often produces radical changes in the character and usefulness of the fibre hence the establishment of a separate set of standard grades for abaca strips. In describing the cleaning of fibre the following terms are used:—

"Excellent" when the cleaning is perfect and the product is pure fibre. Material of this description is prepared for tagal braid or other fine textile purposes.

"Good" when the cleaning is slightly imperfect and the product does not wholly consist of separated fibres, but contains strips. These strips are however fine and soft

"Fair" when the product is distinctly coarse and contains a large proportion of strips.

"Coarse" when the product is wholly composed of strips which are wide and contain appreciable proportions of adhering vegetable pulp.

Texture.—The texture of Manila Hemp varies in most cases according to its cleaning but the variety of the plant fron which the fibre is stripped has also an important influence. Some varieties of abaca grown in North and South Mindanao are said to produce medium or hard texture fibres although they are excellently cleaned.

Length.—Abaca fibre is designated "very long" when it exceeds 10 feet ; "long" when it is 8 to 10 feet ; "normal" when it is 5 to 8 feet and "short" when it is under 5 feet.

MANILA HEMP OBTAINED FROM THE DIRECTOR OF AGRICULTURE, BRITISH NORTH BORNEO.

Samples of fibre from *Musa textilis* grown on the Tawan-Kuhara Estate, Tawan, British North Borneo were received at the Department of Agriculture, F.M.S., in May 1924. Similar samples had already been examined by the United States Department of Agriculture, Bureau of Plant Industry, Washington, and had been described as excellent. The tests conducted in Kuala Lumpur gave results which were decidedly below those recorded in Washington and were considered to be inferior to the standard accepted for "Fair current" Manila Hemp.

Further samples of fibre grown on Tawan-Kuhara Estate were submitted for examination in March, 1925. The results obtained on these samples are recorded in Tables I and II.

The letter from the Director of Agriculture, Sandakan covering the fibre submitted in March furnishes the following information relative to the preparation of Manila Hemp in Borneo:—*

"The extraction of fibre commenced within 48 hours after the cutting of the stalks. Precaution should be taken that it does not take longer than this otherwise the fibres are liable to become discoloured and weaker and the stalks will lose some of their sheaths from decaying and drying. The fibres were obtained from the outer portion of the sheaths.

The process of fibre extraction consisted of two distinct operations, first, the removal of the ribbon-like strips of fibrous material from the leaf-sheaths and second, the separation of the individual fibres by pulling these ribbons under a knife.

The labourer sitting on the ground with a stalk of abaca across his knee inserts under the bark of one of the leaf-stems, near the base, a small sharp piece of wood called, "Locnet" and pulls off a strip about 3 inches wide and as long as the stalk. One sheath yields 3 strips. When the strips have been taken off, the remaining fleshy portion is removed and consecutive sheaths stripped down to the central portion of the stalk."

The stripping apparatus used at Sandakan, is very similar to that generally used in the Philippine Islands, so that a detailed description is unnecessary.

"*Factors Influencing the Production of Good Quality Fibre.**

1. Extracting knife.

Many abaca planters prefer to use the serrated rather than the ordinary knife in extracting fibre.

*Notes on the preparation of fibre at the Experimental Gardens Sandakan. reference A.C. 76/25. (3).

2. Time of Extracting the Fibre.

Fibres should be extracted soon after the stalks are cut, otherwise many of the fibres become discoloured and weak.

3. Variety.

Different varieties of abaca produce different qualities of fibre. *Bongolanon* produces coarse and dull fibre, while *Libuton* produces fine and white fibre.

4. Age of the plants.

Fibre extracted from too old or too young plants is weak.

The extraction of fibre should commence just at the beginning of the flowering stage of the plants.

5. Only the fibres of the leaf-sheaths in the middle portion of of the stalk are extracted. The fibre in the outermost 4 or 5 leaf sheaths are weak, due, according to certain authorities, to the presence of silica in the fibre cell wall. The fibre in the innermost leaf-sheaths, on the other hand, are white but also weak."

The correspondence shows that the fibre produced on Tawan Kuhara Estate was grown on a soil of volcanic origin and that as far as can be judged at present the fibre produced from *Musa textilis* grown on soil which is not of volcanic origin gives inferior results. At the present time no conclusive facts are available for publication.

MANILA HEMP AT THE GOVERNMENT EXPERIMENTAL PLANTATION, SERDANG.

The area under Manila Hemp at Serdang is approximately 13 acres, made up of a block 3 acres (approx) planted during the last quarter of 1922 and the first quarter of 1923, also a block of 10 acres planted during the latter half of last year. This article deals with the product of the 3 acre block.

The plants growing at Serdang are the offspring of a few suckers received from the Bureau of Agriculture, Philippine Islands during September, 1909. The original suckers were planted at the Government Experimental Plantation, Kuala Lumpur, and a small plot was maintained there, till the block had been selected at Serdang.

The area is flat, and the soil shows a great variation, especially when one considers the size of the area. A portion of the area is practically pure sand, and the balance is a peaty loam, except fer a small strip of almost pure peat at one end. This strip of peat was flooded by an adjoining spring before being drained.

The soil conditions are not ideal; the sole reason for planting the block in question was to raise a stock of planting material for an experiment on a large scale.

The area is well drained ; one of the plantation main drains runs along the north and part of the east side and there is a drain across the western end which taps the water from the abovementioned spring.

Cultivation – The area was felled, burnt and stumped at the end of 1921. Previous to planting the land was ploughed with a tractor and a double furrow plough. The suckers were planted 10ft. x 10ft. square, in holes 2 ft. x 2 ft. x 2 ft. Immediately before planting the holes were filled in with surface soil taken from the vicinity, in this surface soil a small hole was dug just large enough to take the roots, the sucker was then placed in the hole and the soil well trodden down round it. The planting of the area was spread over a long period, as it was not possible to obtain sufficient suckers of suitable size at any one time.

Shortly after the planting of the crop was commenced *Tephrosia candida* was sown as a cover crop. Two rows of *Tephrosia* were sown between the rows of Manila Hemp north to south, each row of cover being 3ft away from the crop The cover was allowed to grow up till October, 1921, when it was pruned to 3 feet in height and 1 foot in breadth.

It is of interest to note that a few seedlings have been successfully raised at Serdang, and the seedling plants are in every respect as strong as plants of the same age grown from suckers. It is hoped to raise more seedlings, at an early date, as there are now several "tandens" of fruit nearly ripe.

In the event of a reasonable percentage of seed germinating, it should be possible to breed varieties particularly suited to this country if it is found by further experiments that the local conditions, particularly with regard to climate and soil, are suitable for the economic production of Manila Hemp. When the plants were cut the appearance af the block could only be described as fair. Our observations show that the soil is apparently unsuitable for the cultivation of Manila hemp, as the stems of the great majority of the plants are less than 3 feet in height, although they are now two years old and some of the plants have produced poor fruits and died without attaining a height of 3 feet, indicating clearly that the soil in question does not contain sufficient nourishment. Even on the peaty loam the growth has not been good, as only one third of the plants have stems exceeding 3 feet in height. The tallest stem yet grown was only six feet in height, while in the Philippine Islands 8 feet is recorded as the minimum for a stalk. It is possible however that the inferiority of the crop may be caused by the irregularity of the rainfall at Serdang as well as the unsuitability of the soil.

In a note on Manila hemp in the Kew Bulletin 1895 it is stated that "Anything" less than a well distributed rainfall of four or five inches per month will stop their growth." The rainfall records at Serdang show that during the months of July, 1923 and June and July, 192 , the total rainfall for the month was less than four inches. This short dry spell may be partly responsible for the poor growth.

Pests and Diseases.—The following note on insect pests of manila hemp grown in Malaya has been supplied by Mr. B. A. R. Gater, Ag. Government Entomologist.

"Manila hemp being nearly related to the banana plant all insects which attack the latter may be expected to damage it, such attacks being relatively more serious if the hemp is planted on a large scale. Conversely Manila hemp would serve as a reservoir for banana pests, and its importation into the Philippines, together with other species of *Musa*, is prohibited for this reason.

The pests so far recorded on Manila hemp in Malaya are few, the only one which need be mentioned being the Banana Skipper (*Erionotathrax*, L.) which rolls portions of the leaves. *Cosmopolites sordidus*, Germ., a weevil which attacks the base of the stem, is a serious pest in the Philipines, and is at present on bananas in this country.

On the whole bananas in Malaya suffer little damage from insects so that it may be assumed that manila hemp will not be attacked to any great extent. In addition to those mentioned above, the only other banana pest which might become serious to both plants is the weevil *Odoiporus longicollis*, Oliv. Some of the common grasshoppers might develop locally and cause some trouble."

A note by Mr. A. Sharples the Government Mycologist contains the following information.

"The diseases of Manila Hemp *Musa textilis* do not appear to have been closely investigated, but this crop appears to be affected to some degree with diseases similar to those affecting its close relative, the Banana (*Musa sapientum*). The following passages are taken from various numbers of "The Review of Applied Mycology."

"Heart rot" of *Musa textilis*, similar to that of Banana, is due to a fungus not yet described, and causes a continuous slight reduction in the total annual production of Manila Hemp, (in the Philippines). A root rot that follows the attacks of the root borer (*Cosmopolites sp.*) is mentioned, while another root rot, associated with a species of *Marasmius* and apparently not previously reported, occurs occasionally. Leaf spot diseases of slight importance also have been observed.

"Bunchy Top" plantain disease was reported as destroying a plot of Manila Hemp at Peradeniya Experiment Station in 1918. The cause of this disease has not been definitely ascertained. Nematodes sometimes occur in the living portions of the roots, but they are not invariably associated with the disease, so that it is improbable that they produce it. *Rhizoctonia* is prevalent on both the finer and larger roots, but the evidence is insufficient to connect the disease definitely with the presence of this fungus."

Method of Extraction.—The stems were cut in the manner described under a previous heading " Manila Hemp in the Philippine Islands."

The plant stems produced at the Experimental Plantation Serdang were stripped of their foliage and trimmed at the base. The cut stems were weighed and then stood in water to wash the cut sections which had come in contact with the knife. Care was taken to handle the stems as rapidly as possible after cutting. The leaf sheaths were subsequently removed by hand and immediately decorticated.

In the first trials the decortication was carried out on a raspador machine as used for Sisal Hemp and similar material, but it was found that the finished fibre, although satisfactory in other respects, had a very inferior grey mottled colour. In subsequent trials therefore the fibre was extracted from the separated leaf sheaths by the use of a small hand machine which is constructed on the same lines as the machines used in the Philippine Islands by the native small-holders. It should be possible to construct a suitable apparatus of this type out of a hard wood and thus avoid any contact with iron or steel during the preparation of the fibre.

The vegetable juices occurring in the stem of the plant readily change colour in contact with the air, this change is accentuated in the presence of iron or steel with the result that the fibre is stained a dull brown colour which cannot be removed by subsequent washing. Our experience with the preparation of Manila Hemp leads us to conclude that the actual decortication and winning of the fibre is a compartively easy operation and can be carried out readily with a simple and inexpensive machine, but unless particular care is taken to avoid the fibre being stained by the natural juices, after they have come in contact with air, the resulting sample will have a brown colour and therefore can only be disposed of as lower grade material.

In this connection it is interesting to note that there does not appear to be any material difference in the tensile strengths of the brown fibres and the white fibres, and results published by the Bureau of Agriculture, Philippine Islands confirm this observation.

The valuation of Manila Hemp depends largely on the appearance of the finished fibre and our experimental work has shown that the rapid stripping and drying of the fibre is essential in the preparation of a sample with average standard appearance. It has not yet been possible to produce a fibre at the Department of Agriculture, F M S. & S.S. better than that submitted by the Director of Agriculture, Philippine Islands as "current" Government Grade E. It is not known whether this is entirely due to inefficient methods of preparation or to the inherent characteristics of the variety of *Musa textilis* being grown at the Government Experimental Plantation, Serdang. According to observations on forty seven varieties of abaca grown under Los Banos conditions, the texture of the fibre is a character depending on the variety of the plant. Whereas the colour and

strength of the fibre depend upon the position of the leaf sheath. This is confirmed by the results obtained from the examination of the samples of fibre from Sandakan.

Examination of Fibre.— The hanks of fibre when dried at room temperature were sampled in accordance with the established practice of the Philippine Islands Government and subjected to a chemical examination as well as breaking strain tests.

For convenience in comparing the results obtained on the Serdang fibre with the results obtained on the British North Borneo. and the Manila fibre, the figures for all samples are recorded together. (See Tables I. page 136 and II, page 138)

Comparative Results of Examination of Samples of Manila Hemp at the Department of Agriculture, Kuala Lumpur.

Description of Samples.—1. Sample from Manila "Extra Prime." Colour absolutely white with a good lustre, cleaning "Excellent," texture "Soft and silky"; length "Normal"; This fibre is obtained from the interior sheaths around the core of the abaca stalk.

2. Sample from Manila. "Superior Current." Colour a light ivory yellow and portions quite white, with a good lustre. Cleaning "Excellent;" texture "Soft"; and length "Normal"; the majority of it being used for the manufacture of ladies' hats and some woven fabrics.

This grade can be regarded as the highest used for cordage purposes.

3. Sample from Manila "Good Current". The predominant colour is a very light golden brown though much is yellow to white. Cleaning "Good"; texture "Soft to Medium"; length "Normal" to "Long."

This grade may be regarded as the lowest of the superior grades and is the fibre most extensively used in the manufacture of marine cordage and high grade ropes.

4. Sample from British North Borneo. Labelled B. Received March 1925. "Extracted from the leaf stalks between the outer and inner leaves, representing the great bulk of the fibre." The fibre is equivalent in colour to "Current" Manila Hemp. Cleaning "Good", texture "Soft"; length "Long."

5. Sample from British North Borneo. Labelled C. Received March, 1925. "Extracted from the short stalks near the outer edge of the stem. The colour is equal to "Streaky Current" Manila Hemp. Cleaning "Good"; texture "Medium"; length "Normal".

6. Sample from British North Borneo. Labelled D. Received March 1925. Extracted from leaf stalks near the centre of the stem. Colour equal to "Superior Current" Manila Hemp; cleaning "Good"; texture "Soft"; and length "Normal".

7. Sample from the Government Experimental Plantation, Serdang, F.M.S. Prepared 22nd. January, 1925. Colour equal to "Current" Manila Hemp, cleaning "Good", texture "Medium" and length "Normal."

8. Sample from Government Experimental Plantation, Serdang, F.M.S. Prepared 3rd February, 1925. Colour equal to "Streaky Current" Manila Hemp, cleaning "Good"; texture "Medium"; and length "Normal."

9. Sample "A" from Government Experimental Plantation, Serdang, F.M.S. Prepared 30th March, 1925, colour equal to "Current" Manila Hemp, cleaning "Good"; texture "Medium"; and length "Short."

10. Sample "B" from Government Experimental Plantation, Serdang, F.M.S., prepared 30th March, 1925. Colour equal to "Superior Current" Manila Hemp, cleaning "Good"; texture "Soft"; length "Short."

TABLE I.

Tensile strength Determinations carried out at the Department of Agriculture, F. M. S.

Sample.	Description.	Number of tests.	Average weight of Sample grms.	Mean breaking load, Kgs.	Mean Tensile Strength Kgs. per unit grm. metre.	Standard deviation. ±
1	Manila "Extra Prime" Government Standard -	10	0.3929	18.0	46.1	5.1
2	Manila "Superior Current" Government Standard -	10	0.517[illegible]	20.1	40.05	6 3
3	Manila "Good Current" Government Standard -	10	0.6270	27.2	42 8	2.63
4	British North Borneo "B" -	12	0.5369	29.36	54.41.	9.25
5	British North Borneo "C"	12	0.5944	30.78	51.45	7.7
6	British North Borneo "D"	12	0.5117	21.17	41.27	7.2
7	Gov. Expt. Plantation, Serdang Jan. 30th 1925 -	20	0.6109	23.25	38.14	9.07
8	Govt. Expt. Plantation, Serdang, Feb. 3rd 1925 -	16	0.6806	26.04	38.79	5.69
9	Govt. Expt. Plantation Serdang Mar. 3rd 1925 "A"	10	0.6148	27.6	45.0	3.88
10	Govt. Expt. Plantation Serdang, Mar. 3rd 1925 "B"	10	0.7136	27.98	38.98	3.21

The determinations of tensile strength were caried out on a Schopper Testing Machine in accordance with the procedure standardised by the U. S. A. Bureau of Standards. The samples of fibre were selected, their length measured, and then weighed on an analytical balance. Each sample consisted of twenty single fibres, the breaking load was determined at each end and in the middle of each sample. The testing length, that is, the distance between the fixed jaws of the machine at the commencement of the application of the load was twenty centimetres.

The average of the three breaks gives the breaking load for one sample. The breaking load divided by the average weight per metre gives the tensile strength per unit gramme metre.

In weighing the samples care was taken to standardise the conditions governing the moisture content of the fibre under examination. The results recorded in Table I were obtained on samples of fibre having an average moisture content of 12 per cent.*

Chemical Examination of Manila Hemp.—For purposes of comparison the standard samples of fibre obtained from the Philippine Islands were subjected to a chemical examination in accordance with the procedure standardised by Cross and Bevan and adopted by the Imperial Institute.

The results are recorded with those obtained from examinations of two samples of fibre produced in British North Borneo and two samples of fibre produced from the Government Experimental Plantation, Serdang. (See Table II overpage).

Conclusions.—Consideration of these results leads to the conclusion, that pending further experimental work, it is not yet possible to advocate the cultivation of *Musa textilis* as a commercial proposition in Malaya. It is evident that the initial work has not resulted in the production of a fibre as good as that obtained in British North Borneo, which again is inferior to the "Prime" Abaca produced in the Philippine Islands. The size of the plants grown at Serdang. compared with plants grown in the Philippines necessitate the handling of plants on a much larger scale than hitherto before any conclusions can be arrived at as to the economic possibilities of the local product.

In conclusion the authors beg to acknowledge the receipt of samples and information provided by the Director of Agriculture, British North Borneo and the Director of Agriculture, Philippine Islands. Thanks are also due to Mr. Gunn Lay Teck, Assistant Analyst, Department of Agriculture, F.M.S. & S.S. for assistance in carrying out some of the chemical analyses, and to the Fibre Committee, Department of Agriculture, F.M.S. & S.S. for assistance in connection with the publication of these notes.

*This may account for the difference in tensile strength of standard Manila Hemp tested in the F.M.S. and elsewhere. Our results are uniformly lower than those recorded by the U S.A Bureau of Standards, Washington. No figures are available to show the humidity in the latter case.

TABLE II.

Results of Chemical Examination of Manila Hemp.

Sample.	Moisture.	Results calculated on the "Moisture—Free" Sample.					
		Ash.	Loss on washing with water.	Loss on washing with acid.	Hydrolysis "A" Loss.	Hydrolysis "B" Loss.	Cellulose content.
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
1. Grade A. Extra Prime Manila ...	9.70	1.20	0.17	0.55	12.62	17.61	76.66
2. Grade F. Current Manila ...	11.05	1.35	0.06	0.62	11.86	15.46	76.76
3. Grade 1. Good Fair Manila ...	11.45	1.69	2.59	3.16	15.53	21.83	74.08
4. Grade V². Fair No. 1 Manila ...	12.00	4.20	8.24	8.52	18.75	29.32	62.77
5. B. N. B. received May, 1924 ...	14.08	2.04	trace	trace	12.24	16.13	78.40
6. B. N. B. received March, 1925. Sample "C"	10.00	1.82	trace	1.40	14.70	16.00	77.40
7. B. N. B. received March, 1925. Sample "D"	12.00	1.96	trace	2.67	15.30	17 3	75.20
8. Serdang Fibre received March 1925.	13.9	2.33	trace	5.06	14.8	16.2	73.5

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A PRELIMINARY NOTE ON A PHYTOPHTHORA ASSOCIATED WITH PATCH CANKER OF HEVEA BRASILIENSIS IN MALAYA.

By A. Thompson.

PATCH CANKER of *Hevea brasiliensis* has, up to the present, been attributed to the fungus *Phytophthora faberi* (Maubl). Petch (1) in Ceylon, and Rutgers (2) in Java have proved that the disease can be produced on *Hevea brasiliensis* if the bark is inoculated with *Phytophthora faberi.* Both these investigators used *Phytophthora faberi* isolated originally from Cacao or Nutmeg, but, as far as available literature shows, no investigator has originally isolated *Phytophthora faberi* from Patch Canker of Hevea. In November 1924 some cases of a disease on Hevea came under observation and the writer was successful in isolating a fungus from the diseased tissues. The symptoms of the disease resembled those of Claret-coloured Canker, although a claret coloured patch was only seen in one instance. The fungus is considered to be a *Phytophthora* with a method of liberating zoospores closely resembling that found in the genus *Pythium.* No other method of zoospore production has been observed.

The fungus differs from *Phytophthora faberi* not only in this particular, but also in the growth of large numbers of oogonia and antheridia in pure culture, and in the size of sporangia and oogonia. Maize agar, Potato agar and Lima bean agar are suitable media for the growth of the fungus. Sporangia, chlamydospores, oospores and antheridia appear freely on all these media. Details of attachment of the antheridium to the oogonium have not yet been definitely determined. The diameter of the oospores is from 14—19 microns with a mean diameter of 16.7 microns. The sporangia are mostly spherical and on Potato agar measure from 16—24 microns × 15 — 23 microns with a mean length of 19.9 microns and a mean width of 18.6 microns. These figures are much smaller than those obtained for *Phytophthora faberi.* The apical papilla is not as a rule seen until the sporangia are placed in water and zoospore formation begins. In the majority of cases observed the procedure is as follows:—The papilla grows out into a tube which may be as long as the length of the sporangium. The contents of the sporangium flow out through this tube and form a vesicle attached to the tube. This is usually complete about 10 minutes after the tube has begun to grow. As soon as the contents of the sporangium are contained in the vesicle the latter, which is roughly spherical, becomes slightly agitated and the protoplasm splits up into zoospores. This usually takes 5 minutes and meanwhile the agitation of the vesicle increases until it is jerking about vigorously in the water. The zoospores then separate and for a few seconds swim about inside the vesicle, which finally ruptures at one side and the zoospores escape quickly. In twelve observations made the process took from 20—25 minutes from the first appearance of the papilla to the final rupture of the vesicle. The zoospores come

to rest after an hour or an hour and a half, round off, and germinate, usually by a single germ tube.

Successful preliminary inoculation experiments on Hevea have been carried out and the fungus again recovered from the inoculated trees. The method of inoculation was as follows :—

(1) About ¼ in. square of virgin bark was lightly scraped on 6 trees and mycelium of the fungus applied, a piece of sterilised cotton-wool was fixed over the inoculation with plastascine and kept moist as the weather was dry. After 14 days the inoculations were examined and it was found that on all the inoculated trees the bark round the inoculation was discoloured greyish black and dead with lateral extension of about 1½ ins. on each side of the inoculation. After a mouth the patches were about 3½ inches in diameter and had penetrated in as far as the laticiferous layer. Controls remained normal.

(2) A watch glass was cemented with plasticine on the virgin bark just below a tapping cut of a tree in tapping. The top of the glass was not cemented and through this opening a suspension of zoospores in water was poured. The water almost filled up the cup formed by the watch glass. This was left on the tree for four days and then removed. Three weeks later, on removing the scrap, a dark brown line was seen on the tapping cut. This line was about half a millimeter in width and about 3½ inches long. It had not spread in to involve many of the latex rings and latex was still obtainable from the cut. After another week the bark below the cut was scraped and found to be diseased in a patch of about 4 inches in diameter, The bark was moist and of a purplish colour. A similar inoculation using water only gave no result.

From the above inoculations it would appear that this fungus, which is not *Phytophthora faberi,* is the cause of Patch Cauker of Hevea in Malaya. Both Petch and Rutgers base their conclusion that *Phytophthora faberi* is the cause of Patch Canker of Hevea on the facts obtained by inoculations with *Phytophthora faberi* isolated from Cacao and Nutmeg.

It seems probable that, in mixed Cacao and Hevea areas, where the Cacao is attacked by *Phytophthora faberi*, this fungus would be responsible for the canker in Hevea. In view of the results obtained above, however, it would be desirable to have the cause of Patch Canker of Hevea definitely proved in Ceylon and Java by isolating a fungus from Hevea Canker and proving it to be the cause of the disease by inoculations. If the fungus proves to be *Phytophthora faberi* the position is then established as regards the disease in the two countries mentioned.

In a report to the Brown Bast Investigation Committee in 1918 Mr. R. M. Richards, Mycologist to the Malay Peninsula Agricultural Association, reports having isolated a *Phytophthora* from Patch Canker of *Hevea* and by inoculations reproduced the disease. He considers the fungus to be a species of *Phytophthora* as yet unnamed.

The writer has been unable to obtain further information on this fungus, owing to Mr. Richard's absence from Malaya, but it seems probable that the two fungi isolated in Malaya will prove to be identical.

References.

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TRACTOR PLOUGHING FOR PADI CULTIVATION.

By H. W. Jack.

THE methods employed by Malays in the cultivation of padi are frequently criticised as wasteful, laborious and antiquated, but the more such methods are studied the more will the student realise that they have been evolved from long years of practical experience and that many practices in vogue are not so 'ridiculous' as may appear on first consideration.

The critic is generally unacquainted with the real conditions under which padi cultivation can be carried on successfully and frequently forgets the important facts that the industry is entirely conducted by small holders and that they have little or no capital.

Rarely can good padi land be found which is uniform in respect of soil texture and composition and free from soft pockets which may result from the removal of jungle stumps or may mark previous slimy wallowing pits of the padi buffalo or denote abandoned wells.

Further; the nature of a padi area frequently necessitates terracing to such an extent that the unit area is reduced to a very small block which has to be bounded by a 'batas' or bund in order to hold up the water supply, so essential for the production of profitable crops. Moreover, cultivation is always carried on under wet weather conditions. All these factors bear a highly significant relation to methods of padi cultivation which, with long practice, have become customary, and the poverty of the cultivators certainly militates against the operation of some of the more modern forms of cultivation, such as tractor ploughing, at any rate until native agriculture becomes more organised.

The practices which are most subject to criticism are those of ploughing the land and harvesting the crop, and this note is intended to portray briefly the relative merits of buffalo ploughing in contrast to ploughing by tractor in the light of existing conditions of rice growing.

The tillage of land for the cultivation of padi is entirely performed by so-called 'antiquated' methods which have been described in the Malayan Agricultural Journal, Vol XI, No. 5, 1923.

The native plough is a much malinged implement and is wrongly held responsible by critics for unsatisfactory padi crops. True, the soil is often far too scantily tilled but this is no fault of the plough — the cultivators may not incline to industrious labour or there may be shortage of buffaloes or each man may be attempting more than he can cope with thoroughly or the rains which soften the soil may be late.

The native plough is simple in construction, light, and of easy draught and shaped for shallow work which is all that is required for

the rice plant. Tractors are cumbrous in the padi fields, complicated in construction, costly to purchase, expensive to work on small areas, require constant supervision and are apt to dig themselves in whenever they strike a soft pocket of soil, still they have useful points in their favour in being able to furrow and turn hard soil and to work more rapidly than the buffalo.

On the opening of a new padi experiment station at Pulau Gadong in Malacca in 1922 the land selected was hard and had been under lalang for at least 10 years and thus offered a good test for tractor ploughing.

In 1922 a block of 5 acres was ploughed and harrowed with a Fordson tractor, thanks to Messrs. Wearne Bros., Ltd., who kindly offered to do the ploughing, free of cost, as a demonstration. While the 'Fordson' ploughed the land well—in fact too well, the furrow being rather too deep for the first season's growth of padi on previously untilled land—the work proved much more costly than was anticipated, though the condition of the land was somewhat adverse and the driver was unaccustomed to ploughing. The land was ploughed at the rate of 2 9 acres per day of eight hours at the calculated cost of $11.50 per acre. The slow working was mainly due to the inexperience of the driver in the handling of the machine, particularly the plough, coupled with the rough nature of the soil which was packed with lalang roots and the smallness of the land divisions necessitating frequent turnings which cost fuel and wasted time.

According to Mr. Fairweather (the Field Officer who conducted all the trials) subsequent ploughings could probably have been done at a cost of $8/- to $9/- per acre and at an increased rate, especially if the driver in the meantime gained more experience in handling the plough, and considering that occasional obstructions had been removed during the first ploughing.

The calculated cost of harrowing and cross harrowing, that is, two harrowings, was $2.30 per acre, so that if $8 50 be regarded as the cost of ploughing previous tilled land, the cost of preparing the land for planting should be less than $11 00 per acre, to which must be added the expense of making batas and the establishment of nurseries.

Some 7 acres of additional new land were ploughed in 1923 using a caterpiller type of tractor—the Cletrac—kindly lent by the Agriculturist for the occasion. This tractor proved very troublesome at first but with a change of driver did very good good work except when soft pockets were encountered when it dug itself in just as effectually as did the 'Fordson.'

Ploughing and harrowing costs with the 'Cletrac' were much the same as in the case of the 'Fordson,'-though actual figures are not available. The 'Cletrac' disc harrowed land which had been ploughed the previous season at the rate of an acre per hour.

Of course, these tractor working costs do not include cost of machinery or its transport or interest on capital or depreciation or

supervision, all items which would very appreciably increase the working cost particularly on a small area.

In contrast, buffalo ploughing costs in Malacca have been worked out by Mr. Fairweather at $2.50 per acre including depreciation of buffalo and implements, (though contractors always want $8/- to $10/- per acre) and harrowing and rolling each at about the same rate as ploughing. While costs of Malay labour and assessment of depreciation on buffalo and implements are difficult to calculate, the work of ploughing takes a Malay 5-6 days, harrowing 3 days, and rolling 1-2 days, or in all 9-11 days labour per acre.

Malay contract rates for ploughing, harrowing and rolling take no cognisance of the arduousness of the buffalo's task but are merely based on the number of days' work each operation is likely to take and hence their complete contract rates for preparing the land vary between $16/- and $23/- per acre, whereas all these operations have been accomplished, using Departmental buffaloes and paying wages at the rate of 50 cents per day of 5 hours, at a cost of $5/- (exclusive of cost of upkeep of buffaloes). From the Malay standpoint the depreciation and upkeep expenses of keeping a buffalo are immaterial, as is depreciation of implements which they usually fashion themselves and which often last a very long time.

Thus the preparation of land for padi planting using buffalo power costs about $5/- per acre if the cultivator owns his own buffalo, and if he has to rent a buffalo (the rent may amount to $3/- or $4/-) about $9/- per acre, whereas using tractor power the same work costs $11/- per acre, without allowing for any but actual running costs.

Hence the economy and suitability of using buffalo in preference to mechanical power, under existing conditions of padi cultivation, is very apparent.

Tractors may have a future in padi cultivation on large areas where the soils are fairly hard and where irrigation is controlled, especially for harvesting purposes, but they are essentially implements for use on large areas and are only available to capitalists, and as such their adoption is very remote even if co-operation should succeed in overcoming the existing poverty of the average padi planter.

Much of the information on which these brief notes are based is obtained from the files of the Chief Field Officer, to whom thanks are tendered.

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MANURING OF HEVEA BRASILIENSIS.

By F. G. Spring.

EXPERIMENTS on the manuring of Hevea have been conducted in Ceylon, Malaya, South India and Sumatra, but the results obtained do not indicate that the application of artificial fertilizers will be an economic proposition in respect of increased yields of latex, except in certain circumstances.

Most Malayan rubber estates have been opened up from areas which have been under virgin jungle for generations and the fertility should be maintained under rubber cultivation without having to resort to fertilizers if precautions are taken to conserve the surface soil. The plantation rubber industry is of recent origin consequently such land has been in cultivation for a few years only. There are exceptions in which rubber cultivation has succeeded other crops such as coffee, gambier, pepper, pineapples, sugar or tapioca ; the soils on such areas were partly exhausted previous to the planting of rubber, chiefly owing to the loss of surface soil caused by lack of suitable methods of conservation. It is probable that the average soils in Malaya are sufficiently fertile to maintain good growth and yields of rubber for many years and that we have not yet reached the stage of diminishing returns. If this is so, it is not surprising that manurial experiments have given indefinite results. On the poorer types of soil, however, it is reasonable to suppose that increased yield would be derived from the application of artificial fertilizers. A system of manuring for annual crops is more easily determined than for permanent crops, particularly in the case of the rubber tree. The effects of the application to soils of fertilizers containing certain plant foods on the yield of fruit, grain, or roots are known, in the case of soils deficient in in such constituents, but the influence of such constituents on yield of latex, the significance of which in the metabolism of the tree require further investigation, is still problematical. It is generally agreed that the rubber tree does respond to manuring in respect of growth and foliage, but little information is available as regards the effect on the yield of rubber. Assuming that there is no appreciable increase in yield in the beginning, this is no proof that the continued application of fertilizers would not ultimately be responsible for an increase in crop. If there is a continued falling off in yields from good land, it is very necessary to search carefully for causes before resorting to the use of fertilizers. Previous H. A. P. M. experiments on six to eight year old rubber indicated no beneficial results from cultivation experiments. Except on certain soils, in which the addition of lime improves the physical character of the soil, or with the object of encouraging the growth of leguminous cover crops, it is questionable whether the rubber tree responds to liming. A normal acid soil may suit the rubber tree.

The high temperature, humidity and large annual rainfall in Malaya cause more rapid decomposition of the soil than occurs in

temperate zones, rendering plant food more rapidly available. Manurial experiments on the rubber tree require special consideration since there are so may factors which may influence the yield that it is difficult to plan field experiments which will reduce the experimental error to a minimum. Factors to be considered are, size and number of plots, variations in the soil, tapping system and quality of tapping, uniformity in growth, distance of planting and variation in individual yield of trees.

Preliminary records of yields in the various plots require to be taken previous to the application of manures when experimenting with mature rubber trees. The chemical analysis of a soil is a guide to manuring but it should be considered in conjunction with other factors. The result of the experiment should be judged by yield, girth, examination of bark, foliage, resistance to disease and the general appearance of the trees. Yield is the all important object to be attained, but it is wise to record other observations as they may be responsible for enabling definite conclusions to be recorded in later years. Although with our present knowledge the use of artificial manures on average land cannot be recommended as a general practice, there is no reason why experiments should not be carried out in order to gain more information. A single test is only of value in relation to the particular type of soil on which the experiment is conducted. A series of trials, conducted on different soils, in a scientific manner, in various parts of the country is required.

The trees which are most likely to be benefitted by manures are those growing on (1) light soils deficient in humus, (2) sandy soils, (3) poor laterite soils, (4) soils which have been under long cultivation previous to the planting of rubber, and (5) soils such as those described in the experiments carried out in Sumatra in which the absence of ammonification and nitrification was recorded.

If any estate manager contemplates manurial work it is advisable that he should consult the Department of Agriculture in regard to the planning of field experiments. It might here be mentioned that practically most fertilizers are now obtainable in this country or from India.

The question of green manuring is not discussed in this paper, since it is proposed to deal with this subject in a later article.

It will be of interest to review briefly some of the previous work on the manuring of Hevea but no assurance can be given that the results in other countries will be obtained in Malaya since conditions may differ particularly in respect of humidity, rainfall and soil.

Anstead (1) reports that the result of practically all such experiments so far conducted has been that unmanured plots give quite as good yields as manured plots.

(1) Manuring of Hevea brasiliensis. R. D. Anstead, The Agricultural Journal of India, Vol. XIII, 1918, page 660.

Bryce and Gadd(2) writing on this subject state that, of the many manurial experiments carried out on rubber, no one experiment, to their knowledge, has indubitably proved that the application of manures has increased the yield of rubber. They state that the application of manure increase the growth and general vigour of the trees, since it is possible to distinguish manured from unmanured fields by their general appearance.

An experiment conducted by Spring(3) showed that over a period of four years (two applications of manure) the total increases of girth in the manured plots in every case, exceed that of the controls.

The latest results reported by Grantham(4) are of special interest. The experiments were carried out on the soils of the H.A.P.M., viz., the red liparite tuff sedentary soil and on the various types of white alluvial soil. Grantham's summary of his results is as follows:

The white soils responded remarkably to the application of sodium nitrate, calcium nitrate and ammonium sulphate and the typical deterioration characteristic of the older rubber on these soils was arrested. By repeated applications, the trees were improved until they equalled the trees on the good red soil in yield and appearance. The effect on the bark renewal was also pronounced and to this is probably to be attributed the fact that a single application produces a more prolonged effect on yield than on appearance. Sodium nitrate gave no effect on the red soil.

The use of basic slag (Thomas phosphate), potassium cloride and lime was without effect on the white soil or on the red soil. Superphosphate was actually harmful, probably owing to its acidity.

Green manuring with mimosa was also without appreciable result on the white soils.

Attention must be directed to the fact that the results described above have been obtained on the special soil types peculiar to a part of the East Coast of Sumatra, and it by no means follows that similar results will be obtained on other soil types. It is necessary to carry out field experiments on each characteristic soil type, before proceeding to practical manuring.

Grantham in his general discussion of the results reports:—" It is evident that the deterioration which normally results from the more intense competition for nutriment in the older rubber on the white soils is entirely due to one factor, viz. nitrogen starvation. Once this

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(2) Department of Agriculture. Ceylon, Bulletin No. 68, page 70. Yield and Growth in Hevea brasiliensis. G. Bryce and C. H. Gadd.

(3) Manurial Experiments with Young Rubber at Kuala Lumpur. Agricultural Bulletin, F. M. S. Vol IV, No. 4, page 105. F. G. Spring.

(4) Manurial Experiments on Hevea. Archief, Jaargang No. 8 Augustus 1924, page 501. J. Grantham.

deficiency has been satisfied by the application of an available form of nitrogen, the growth and yield of rubber becomes fully equal to that on the red soil. If it is not satisfied deterioration is progressive. One application of nitrate is sufficient to arrest the deterioration for 3 or 4 years but, for actual improvement, applications at shorter intervals are necessary. It is probable that the most economic result is obtained by the application of 5 lbs. of sodium nitrate or 4 lbs. of ammonium sulphate per tree once in two years, although yearly application may attain the maximum result more quickly. So far no deterimental effects on the soil have been noted from intensive manuring over 5 years.

The reason why nitrogen starvation occurs in the white soils is not entirely clear but it is probably connected with the low bacterial activity of the soils as regards ammonification, nitrification and nitrogen fixing. It is also probable that this low bacterial activity is responsible for the failure of green manuring to produce results. Green manures certainly form nodules (many more on the second crop than on the first) but the nitrogen fixed presumably does not become converted to an available form. The impermeable nature of much of the surface soil and of practically all the subsoil, due to this colloidal content, produces conditions more favourable to de-nitrification than to nitrification. Where nitrification is good, as in the low peaty clay soil, there is no nitrogen starvation. The case of the red soil is somewhat anomalous as it also has a low bacterial activity, but there is a much greater volume of soil available and the root system is so much better developed owing to the absence of any impermeable subsoil or high ground water level that the tree is probably able to obtain a sufficient quantity of nitrogen. Certainly there is no nitrogen starvation or other deficiency on the red soil."

Received for publication 31*st March*, 1925.

NOTES.

(*a*) Despatch of Rubber Samples to the Department of Agriculture for Examination.

The attention of managers of estates and others who send samples of rubber to the Department for examination is directed to the following Gazette Notification—F.M.S. Government Gazette Vol. XVI No. 26 of 12th December, 1924, page 2360, Notification No. 8538 which reads as follows :—

In exercise of the powers vested in him by section 17 of "The Customs Enactment, 1923", The Chief Secretary to Government hereby prohibits the importation of unvulcanised rubber into the Federated Malay States with effect from the date of this notification.

This prohibition shall not apply to—

(*d*) Samples of unvulcanised rubber not exceeding 11 pounds in weight sent by parcel post and marked " Rubber Samples."

(*b*) Rubber Loop Shock Absorbers.

A useful new application of rubber described in " The Rubber Age" (U. S. A) Vol. XVI No. 10/1925 is a shock absorber which consists of a band of rubber about 3 inches wide and ½ inch thick. The length of the strip will depend on the clearance between the frame of the chassis and the axle. The strip is looped under the axle and the ends are attached by means of a clamp to the frame of the chassis.

These absorbers are stated to be the least expensive spring checking device on the market. The manufactured straps are specially compounded and will stand a pulling strain of 4000 lbs per square inch. and the shock absorber is stated to have great wearing qualities. This device is made in the United States of America and is stated to have been on the market for eighteen months.

A similar device has been made by Mr. Wilkinson in Malaya using rubber prepared by his process, which should prove very useful and effective.

B. J. E.

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; and the Malay States Information Agency, 88, Cannon Street, E C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV	(1913-16) VIII & IX (1920-21)		price	$5.00 per volume.
Vol. V	(1917)	Nos. 1, 2, 3, 5 & 6	,,	2.50 per set.
,, VI	(1918)	,, 1, 7, 8 & 12	,,	2.00 ,,
,, VII	(1919)	,, 2—6	,,	4.50 ,,

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

Vol. X (1922)	Price $5.00 per volume.
,, XI (1923)	Price $5.00 per volume or 50 cents per single number.
,, XII (1924)	,, ,, ,, ,,

Back numbers of Vols. I—X will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased at the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co.

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, Government Entomologist, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher.
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, Government Entomologist, 1910, reprint 1916, 20 cts. (Out of Print.)
4. A Lepidopterous Pest of Coconuts, *Brachartona catoxantha, Hamps*, by H. C. Pratt, 1909.
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909.
6. Preliminary note on a Branch and Stem Disease of *Hevea Brasilienisis*, by W. J. Gallagher, 1909.
7. Coffea Robusta, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910.
9. Die-Back Fungus of Para Rubber and of Cacao, by K. Bancroft, 1911.
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher, 1910.
11. Coconut Cultivation, by L. C. Brown, 1911.
12. Padi Cultivation in Krian, by H. C. Pratt, 1911.
13. A Root Disease of Para Rubber, *Fomes Semitostus*, by K. Bancroft, Assistant Mycologist 1912, 20 cts.

C = Cancelled

THE

Malayan Agricultural Journal.

Vol. XIII.] JUNE, 1925. [No. 6.

A COLLAR DISEASE OF RUBBER SEEDLINGS.

BY A. SHARPLES.

AN interesting disease of basket seedlings of Rubber has been studied recently. The writer has only once previously, in 1914, seen this disease in Malaya.

The prominent fungus in both cases was the common *Diplodia* sp., responsible for the "Die-back" of Rubber branches. The stems of seedlings which were 9 inches to 1 foot in height were attacked at the collar, about ground level. The cortical tissues were first attacked for about 1" above the ground; later the whole of the stem tissues over this area become involved, and the head of leaves finally falls over.

A similar disease has been reported from Java and Ceylon. The description given by Petch (2) corresponds closely with the symptoms observed in Malaya, but the causal fungus is given as *Pestallozzia palmarum* (Cke). No trace of *P. palmarum* (Cke.) was found in the diseased Malayan seedlings, but both fungi, i.e. *Diplodia* sp, and *P. palmarum* (Cke.) are, in general, but weakly parasitic, so that it is probable that either fungus could bring about almost similar symptoms.

The disease in Ceylon was found in nursery beds and as Petch points out (l.c.) the same ground is often continuously used for nurseries and consequently the soil becomes sour and quite unfit for use in nursery beds. Such conditions favour the development of weakly seedlings which are unable to resist the attacks of weakly parasitic fungi.

In both cases observed in Malaya, the seedlings were in baskets, so that the soil was used once only. Large, permanent, adjoining nurseries, with ordinary seedlings for stumps, were free or had only a few cases of the disease, as compared with the basket seedlings.

A careful inspection of the beds in which the basket seedlings were growing showed, in only one single case, a heavy infection

before planting. The remaining beds of basket seedlings in other situations were quite free.

There seems little doubt that the heavy infection in certain fields was primarily due to the planting of seedlings obtained from a previously infected bed. The writer is of the opinion, however, that a considerable number of seedlings first showed definite signs of infection in the fields and that considerations such as soil sourness enabling a weakly parasitic fungus to attack weakly individuals will not account for the whole of the symptoms observed.

Butler (1) calls attention to a somewhat similar disease on Tea seedlings and though no parasite has been found in connection with the disease in India, yet in Java and Ceylon, a fungus has been found in the diseased parts. Both in Java and India, the original cause of this disease has been assigned to alternations of high humidity and great heat. The conditions were most closely examined in India, and it was found that the disease (i.e. on Tea seedlings) occurred in a season in which there was, first a long drought with considerable heat towards the end, then, continuous heavy rain for about a fortnight, and, then several extremely hot days. During these, the disease became evident. The whole trouble was attributed to climatic changes in India, but in Java and Ceylon, the fungus present is considered to be the direct cause, Java opinion holding, in addition, that abrupt climatic changes prepare the way for the attack.

Steinmann (3) in his recent book describes a disease showing very similar symptons. This author evidently has not met with the disease except in nursery beds where he says it "occurs sporadically only", and has been erroneously attributed to *P. palmarum*. He also points out that fungi of the genera *Phoma*, *Colletotrichum* and also *Diplodia*, have been found associated with the affection, but proved to be secondary.

The most important difference between the description given by Steinmann (l.c.) and that observed in Malaya, is that in Java "in exceptional cases only the young plants die off completely," while in this country, the exact opposite is found, i.e. that practically no recoveries can be recorded. The concensus of opinion appears to be that a purely physical cause is to be regarded as primary, viz. "excessive heating by solar heat", and that the fungus is purely secondary and often superficial. While no definite work in the shape of isolations or inoculations was undertaken, the writer, while agreeing with the view that the primary cause is scorching, is inclined to attach more importance to the effects produced by the fungus, than Steinmann.

Steinmann says "the cause of the disease (i.e. in Java), as a rule, is that the seedlings have been planted too far down in the ground, so that that part of the stem which is still green and not yet protected by cork in the bark against external influences, is brought into contact with the hot upper layer of the greatly heated soil surface and is scorched by it. "This quotation obviously cannot apply to

the conditions in this last Malayan outbreak, where large numbers of diseased seedlings were found which had grown naturally from selected seed, and had not been removed from the nurseries.

Abrupt changes in climatic conditions, combined with the presence of a fungus, may possibly account for the latest Malayan attack. The disease appeared during a hot dry period in December, rather unusual weather for Malaya at this time of the year. Watering, two or three times daily was being undertaken, and in the writer's opinion, the soil in the baskets containing the diseased seedlings was being kept much too wet. Such conditions would probably result in producing a state in the host plant, which would favour the entry of such a fungus as the *Diplodia* sp. under consideration.

Treatment was advised in the report as follows:—

Nursery beds containing few diseased seedlings, were to be removed carefully from the vicinity of the heavily infected bed. When removal was complete, after thorough inspection of lifted plants to prevent leakage of diseased plants, the heavily infected bed was to be treated. All diseased plants in this bed were to be lifted and immersed in a receptacle containing 5% Izal. After thorough immersion for a minute or two, the plants were to be placed in a box prior to removal for burning. A count had to be kept, as far as possible, to obtain some idea of percentage infection. After this treatment, a second inspection was to be made ten days later and diseased plants removed as before, and a count again taken. If the percentage infection decreases considerably no further treatment is required. It was recommended that no watering of the bed should be undertaken, except in case of wilting owing to prolonged dry weather.

Owing to the absence of a Resident Manager on the estate the above scheme would have taken some time to put into operation. In order to expedite control arrangements, the Manager decided immediately to spray the badly diseased bed with 5% Izal. The result of this spraying was that all badly diseased plants died, while the healthy ones survived. On this result, lightly infected nursery beds were subjected to the same treatment and no losses of healthy plants are to be reported.

Although in this case, spraying with 5% Izal does not appear to have done damage to healthy seedlings, the writer would urge caution regarding the use of more than a 2½% solution, for cases of burning have been observed, using stronger solutions.

Treatment in the fields which showed numerous diseased plants has to be considered in relation to the possibility of the soil becoming infected with the spores of the fungus in the neighbourhood of diseased plants; healthy supplies might then become infected fairly quickly. To remove diseased plants, the baskets and soil containing the plants were lifted carefully and taken away for burning. The

soil about the hole was opened up and lightly sprinkled with lime. The ground was allowed to remain open for not less than a week, when the lime was well mixed with the soil before resupplying.

The above measures were completely successful and the disease has now disappeared.

(1) Butler, E. J. ... Fungi and Disease in Plants, 1918. Page 464. Thacker, Spink & Co., Calcutta and Simla.

(2) Petch, T. .. The Diseases and Pests of the Rubber Tree, 1921. Page 163. Macmillan & Co., Ltd., London.

(3) Steinmann, A. ... Diseases and Pests of *Hevea brasiliensis* in the Dutch-East-Indies, Page 73 –75, (Dutch Text).

Received for publication 23rd May 1925.

STUDIES ON HEVEA LATEX.

III. PROTEINS AND ALLIED BODIES.

BY W. N. C. BELGRAVE.

IN continuation of former studies on latex constituents[1] work has been carried out on the manner in which the protein nitrogen in latex is distributed. Owing to the peculiar difficulties presented by Hevea latex the results are unsatisfactory and incomplete, but it is felt that they may serve as a guide to future work, and are therefore placed on record.

At the outset it must be realised that any study of distribution based on results obtained after coagulation* will give a true picture of the distribution actually existing only in so far as change at the time of coagulation is avoided.

Bacterial action may be avoided by adding sufficient acid (2% of 10% acetic) to bring about rapid coagulation and then warming slightly (not above 45° C) to ensure rapid and clear separation of serum. By this means the whole operation can be completed in one hour from the time of collection. The weak acid present is unlikely to bring about hydrolysis to any serious extent. There remains the question of the action of proteolytic enzymes. So far unlike many other latices no such enzyme has been recorded in Hevea latex, and the writer, as a result of experiments to be described later, is satisfied that no enzyme exists in latex active enough to bring about serious changes in the composition of the nitrogen bodies within the time limits of the experiments which follow.

QUALITATIVE.

On coagulation of latex it is well known [1, 3] that part of the N is taken down by the coagulum, while of the remainder left in the serum part is accounted for by a heat coagulable protein (which may also be obtained on neutralisation.) Heating at the neutral point causes no further precipitation and therefore meta-proteins must be taken to be absent. Half saturation of the serum with ammonium sulphate gives no precipitate but full saturation does; according to the usual classification, the body precipitated is a secondary albumose. There remain amides and amino-acids which may be demonstrated in the usual way.

QUANTITATIVE.

Following the methods which Osborne and others [4, 5] have applied to the proteins of alfalfa—the following procedure was adopted :—

(*a*) After rapid coagulation as described above the rubber was passed without washing through a creping machine and the serum collected.

*The writer has, unlike Hauser,[2] been unable to obtain satisfactory filtration of latex through ceramic or other filters—unfortunately Hauser has not given details of his filters.

(*b*) The crepe from (a) was soaked in 95% alcohol for 5 minutes then recreped, the alcoholic liquor being repeatedly poured over the rolls.

(*c*) The crepe from (b) was soaked in .3% aqueons Na OH and treated as above.

(*d*) The crepe from (c) was heated for 5 minutes with 3% alcoholic Na OH and after cooling was treated as above.

The first aqueous serum was then mixed with an equal volume of 95% alcohol and the precipitate after settling collected and washed. Lead acetate was added and after removal of the precipitate of albumoses etc., mercuric acetate and sodium carbonate after the method of Neuberg to precipitate amino-acids. The lead and mercury precipitates were decomposed in the usual manner with H_2SO_4 and H_2S respectively.

Kjeldahl determination gave the following results :—

TABLE I.

2000ccs latex (approx. D.R.C. 40%) containing 5.49 grs. nitrogen = 0.27 %N.

			% of total N. in latex.
Total Nitrogen in 1st serum.	1.6	grs.	33.4
„ „ 2nd „ (cold alcohol)	.08	„	1.6
„ „ 3rd „ „ aq. soda)	.25	„	4.6
„ „ 4th „ (hot alc. soda)	.26	„	4.8
Nitrogen in rubber after above treatment	2 5	„	46.3

Evidently the subsequent extractions in the case of rubber do not remove any significant quantity of material—the method was therefore discarded.

Aqueous Serum—(a)

Four successive lots were treated and gave results shown below :—

TABLE II.

	I.		II.		III.		IV.	
Vol. of latex. ccs.	2000		3000		3000		8,600.	
	grs.	% on latex.	grs.	% on latex.	grs.	% on latex.	grs.	% on latex.
N. content of latex.	5.4	0.27	8.0	.266	7.8	.26	22.4	.26
„ in aq. serum	1.6	33.4	2.7	33.6	2 5	32.0	7.44	33.1
		of N. in Serum		% of N. in Serum		% of N. in Serum		% of N. in Serum
„ „ alc. coag. protein :*	0.06	3.8	0.11	4.1	0.09	.36	0.382	5.14
„ „ Pb.Ac.ppt.	0.133	8.3	0.42	15.6	0.36	14.4	1.05	14.1
„ „ Hg.Ac.ppt.	0.5	31.2	0.47	17.4	0.53	21.2	1.97	26.4
Residual N.			0.8	29.7			2.3	39.8
				66.7				76.0

*Precipitation with acid Hg. Cl_2 after Hg. Ac. gave negligible quantities of ppt.

With the exception of sample 1 in which precipitation with Pb Ac was apparently incomplete, the figures appear to be within the limits of the large experimental error due to dealing with small initial quantities of somewhat indefinite substances.

Taking as a working figure the nitrogen in serum to be 33% of total, distributed-protein 4% albumoses 14% amino-acids, amides etc. 20% and the whole of the residual nitrogen in rubber treated as in Table I to have been in protein form we have on the original latex.

		%	% of total N. in latex.
Protein	-	47.3	say 50
Albumoses	-	4.6	,, 5
Amino acids etc.	-	6.6	,, 7
Nitrogen extracted by alcohol and alkali and not further determined	-	10	,, 10
			72%

The figures, approximate as they are, show what might be expected in the normal course of protein metabolism and do not indicate any special function for the lower products.

The latex used was obtained from mature trees at different periods under different system of tapping—no variations were noted which could be assigned to differences in tapping systems.

THE CONSTITUTION OF THE PROTEINS AND DERIVATIVES.

The difficulties encountered in separating and purifying large quantities of protein from serum together with the lack of certainty that a limited number of hydrolyses can give accurate information as to constitution* put out of consideration any attempt at separation and estimation of the component amino-acids of original protein. All that has been attempted has been, a rough separation into large groups and no claim is madė that accuracy has been achieved even in this. The main object of the work, however, was to obtain results which could enable a very broad comparison to be made with other proteins—and to say for example whether latex protein contains a large amount of non-amino nitrogen like gliadine—or a high diamino content like protamines.

After a number of standard methods of separation had been tried, with unpromising results, resort was made to the recently published carbamate method of Kingston and Schryver[6] which appeared to be applicable to small quantities† For details reference should be made to the original. The essential points of the process

* See in this connection the variable results possible with even very highly purified gelatine—Knaggs and Schryver-Investigations on gelatine VIII Biochem. Joun. No. 5, p. 1106.

† It should be noted that Kingston and Schryver do not claim that this process, in its present form, is complete.

are—the protein is hydrolysed with sulphuric acid, the excess of acid (and humin nitrogen) is removed with baryta—the dicarboxylic acids are removed by precipitation of their barium salts with alcohol, the greater part of the rest of the acids are then precipitated by passing CO_2 and addition of baryta under stated conditions; the diamino acids are precipitated from the decomposed carbamates by phosphotungstic acid—and the mono-acids separated by alcohol, leaving proline in solution.

Two determinations with the same preparation of serum protein gave fair agreement.

Results are given below for protein obtained by insolation of crepe after Spence and Kratz, and for serum protein—alcohol precipitated, after acid coagulation and amino-acids (obtained as above). No attempt was made to deal with the lead acetate precipitate owing to the very mixed nature of this product.

TABLE III.

Quantity.	Rubber Protein. 25 grs.	% of total Nitrogen.	Serum Protein. I 25 grs.	% of total Nitrogen.	Serum Protein. II 50 grs.	% of total Nitrogen.
Total N. by Kj : -	2.79*		2.20*		4.34*	
Humin N. and some aspartic acid -	.41	14.4	.5	22.7	—	—
N. as dicarboxylic acid -	.16	6.2	.162	7 35	0 36	8.3
N. as diamino-acids -	.11	3 9	.07	3.18	0 29	6.6
Glycine -	.047	1.7	.021	95	.185	4.3
Other monamino-acids and hydroxy-proline -	.212	7.6	.149	6 8	.309	7.2
Proline -	.276	9.9	.180	8 2	.254	5 9
Non-carbamating -	.15	5.36	.035	1 6	.115	3 3

In order to test the completeness of separation—further determinations were made of the nitrogen in fractions by Van Slyke's method. This gave the following, percentages of amino-nitrogen.

TABLE IV.

	Rubber Protein % of N. in fraction by Kjeldahl.	Serum Protein % of N in fraction by Kj.
Dicarboxylic acids -	99	102
Di-amino „ -	24	34
Mon-amino „ -	63	85
Glycine „ -	73	92
Proline „ -	69	75
Non-carbamating -	78	trace.

* As prolonged purification was not carried out both the serum and rubber proteins contained a fair amount of ash. This explains the fact that the N. content is lower than usual.

The amino-acid solution.

Preliminary determinations were made with the mercury-acetate solution in Sample IV of Table I. These gave :--

TABLE V.

			% of
N. by Kjeldahl	...	.53	grs. total N.
Amino N. by Van Slyke	...	.23	„ or 43%
Amide and NH_3, N	...	.14	„ „ 25%
Diamino N.	...	.03	„ „ 6%

An attempt was made to effect further separation by the carbamate method.

TABLE VI.

Total Nitrogen by Kjeldahl (4000 ccs solution)		17.4	grs.
Amino Nitrogen by Van Slyke	...	8.4	= 18.2%
Nitrogen as NH_3	...	3.3	= 19.0%
Amide Nitrogen	...	1 3	= 7.5%

The whole was hydrolysed by boiling with dilute acid and warmed in vacuo with very slight excess of $Ba(OH)_2$ till NH_3 ceased to be evolved—then treated as the protein above.

		Nitrogen by Kj. grs.	Nitrogen by Kj. %	% of total Nitrogen in each fraction by Van Slyke.
Dicarboxylic acids	...	1.68	9.7	73
Diamino acids	...	1.55	8.9	81
Monoamino etc.	...	1.98	11.4	88
Glycine	...	2.58	14.6	35
Proline	...	.20	.86	77
Non-carbamating	...	1.55	8.92	89

The Van Slyke figures make it perfectly clear that nothing like a complete separation into groups has been achieved ; further a great nitrogen loss has taken place - on the other hand it appears not unreasonable to assume that the figures are sufficiently accurate for the purpose stated above, viz. to ascertain whether any unusually large quantities of any one group exist. This has not been found to be the case.

The writer at any rate feels that further time spent along this line cannot be justified in the present state of our knowledge of latex. It will be noted that no discussion of the reason for the low nitrogen content of rubber has been undertaken ; this must await a better method of separation than that of insolation.

Summary.

1. The distribution of nitrogen among the proteins, albumoses, amino-acids and amides has been investigated and found to be what might be expected from normal metobolic processes.

2. The constitution of the proteins by groups of amino acids, and the distribution of nitrogen in the amino acids themselves has been investigated, and as far as the results obtained can be accepted as giving a true picture, no unusual features are presented.

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NOTES ON MISCELLANEOUS INSECTS IN 1924.

By B. A. R. Gater.

THE following notes of observations made on some of the insects which passed through the laboratory during the year 1924 are supplementary to the annual report for that year, and include details which could not be incorporated therein.

Little is known of the economic insects in Malaya, and many of the groups are still almost unknown systematically. Hence large numbers of insects hitherto unrecorded in this country are found every year, and in many cases, especially among the smaller insects, new species are found. Some of the insects recorded as of economic importance, i.e., which have been found damaging plant or other material, are present in small numbers only, and constitute very minor pests. On the other hand such insects may increase if suitable conditions arise, and they may be imported into other countries without their natural enemies, in which case they have every chance of becoming serious pests. These notes are published from the point of view of general interest in the occurrence and distribution of species, and as a guide to other countries in regard to insects which might be brought in from Malaya. In some cases considerable damage was caused in this country and the notes will therefore be of interest to Field Officers and Planters, giving some idea of what they may expect if the crops mentioned are planted in their districts.

A small consignment of brazil nuts was sent to this laboratory for examination, and showed the presence of numerous borers, all of which, however, cannot be considered as primary. The Platyrrhinid *Araecerus fasciculatus*, de Geer was present in some numbers, and the Tenebrionid *Alphitobius laevigatus*, F. was also present. Three small moths emerged from the sample: *Setomorpha rutella*, Zell. (Tineidae) *Decadarchis leucopogon*, Meyr. (Lyonetiadae) and *Labdia stibogramma*, Meyr. (Cosmopterygidae). The Gelechiad, *Stegasta variana*, Meyr. was found feeding on the leaves of this plant in the field. The latter has been previously recorded on groundnut and *Cassia* sp.

The occurrence on coconuts of *Promecotheca cumingi*, Baly, was noted some years ago by Burkill in Malacca. The palms were badly attacked over a considerable area, but the beetle apparently died down after a time. It has not been found since that time in the Malay Peninsula, although common in Borneo and the Philippines. On a recent visit to Labuan coconuts were found to have been damaged by two Hispinids, which have since been determined as *Plesispa reichei*, Chap. and *Promecotheca cumingi*. The latter was determined as *Promecotheca* sp. in the laboratory and the specimens were compared with specimens of *cumingi* in the Raffles' Museum, Singapore, which had

been identified by Dr. Gestro, and were found to be similar in all respects. From Burkill's description of the damage to palms in Malacca it appears that it was much more serious than is usually associated with this insect in the Philippines, and a watch should be kept for it on palms in Malaya. Unlike *Plesispa reichei* it damages mature palms and the larva is a true miner.

Kapok has been planted as a pure crop at the Serdang Experimental Plantation, and although this plant is to be found growing near almost every Malay village throughout the country, it has suffered severely from pests. *Hypomeces squamosus* is perhaps the most serious leaf-eating insect, but another Curculionid, *Alcides leeuweni* Hellr. is serious in some cases. In Java it has also been recorded on cacao. Eggs are laid singly inside the young green shoots, a longitudinal slit being grawed out by the female for the purpose. They hatch in three days and the larva appears to feed for three or four months before a quiescent period of three days occurs. At the end of this period an exit hole is made and the larva pupates inside the stem. The pupal stage lasts from 8 to 12 days, but the adult remains within the stem for 4 to 7 days before making its way to the exterior. Adults have been observed to begin gnawing the tender shoots about a week after emerging. Serious damage sometimes occurs if these weevils are numerous, although they appear to attack the weak rather than the vigorous trees.

A Noctuid caterpillar which has been identified as *Beara* sp. attacks the leaves of kapok to some extent, but it is at present of minor importance. The pupal period is 8 days. The species is not represented in the British Museum. Another leaf eating caterpillar is *Dasychira mendosa*, Hbn. (Lymantriidae) which is brown in colour with tufts of yellow hair on the dorsal segments. Pupation takes place a day after the cocoon has been completed, and lasts for five days. At present this is a minor pest only.

The green semi-looper caterpillars of *Anomis flava*, F. which has been known for some time as a minor pest of cotton, were found damaging roselle on several occasions. The pupal period is 6 to 7 days.

On two occasions bananas were reported to have been damaged by a Chrysomelid of the sub-family Eumolpinae, *Nodostoma* sp. This small brown beetle feeds on the epidermis of the young leaves, but does not appear to be serious. The species is unrepresented in in the British Museum. The butterfly, *Amathusia phidippus*, L. which is usually found on coconuts, was taken and bred out on banana leaf.

Maize was badly attacked by *Pyrausta salentialis*, Snell. the larvae being found in large numbers boring in the young shoots, flowers and unripe cobs. Sweet varieties of maize imported from other countries appear to be particularly susceptible to the attacks of

this insect, whereas the common native varieties may be seen growing close to and suffering no damage. *Cnaphalocrocis medinalis*, Guen. which is an occasional pest of padi, was found on maize and was bred out normally.

Chilies were attacked by *Anomala pallida*, F. and *Amsacta lactinea*, Cram. (Arctiidae) The grubs of the former attacked the roots, causing considerable damage, while the caterpillars of the latter fed on the shoots and the bases of the fruits, rendering them quite unfit for market. Only the green fruits were attacked but the large excavation made by the larvae, exposing the young seeds, caused the fruits to rot before they were ripe. This insect has also been recorded on tea and derris.

Croton leaves were badly eaten on several occasions by the larvae of *Amyna punctum*, F. (Noctuidae). The larva, which is a semi-looper, is about 27 m/m long and white to yellow in colour. Two irregular shaped black or dark brown fasciae are situated on the sides of the segments except the last; a short hair arising from the broadest portion of the lower fascia on each segment. A large stellar patch of the same colour is situated on the dorsum of each segment, surrounded by four dark spots from the centre of which arise single stout hairs. This pest is very prevalent and spraying had to be done repeatedly to keep it under, since it entirely defoliated the plants.

Another semi-looper caterpillar which was fairly prevalent was *Platyja umminea*, Cram. which attacked soursop. The larva is over 7 c/m in length when full grown, and of a dull slate-brown colour. Pupation takes place in folded-up leaves on the plant, the pupal stage lasting for 9 to 12 days. Soursop was also commonly attacked by the larvae of *Papilio agamemnon*, L.

Dadap (*Erythrina lithosperma*) was severely damaged by the boring caterpillars of *Terastia meticulosalis*, Guen. and repeated cutting back seemed to have little beneficial effect. The larva, which is white with a brown head, and has a number of brown papillae on the body from each of which arises a short hair, bores into the young green shoots, which wither and die back. Evidence of the presence of the caterpillar is also given by masses of excreta protruding from the stems. Eggs are laid in the axils of the leaves and pupation takes place in a strong silken cocoon within the stem. In one case pupation was observed to take place in the soil, the larva spinning its cocoon inside an earthen cell. *Erythrina indica* suffered slightly from *Agathodes ostentalis* Hbn. the caterpillars of which feed on the leaves. The full grown larva is about 25 m/m long, and is pale green in colour with an orange coloured head. A blue-green line may be seen running along the back and the spiracles are ringed with black.

The fruits of rambutan (*Nephelium lappaceum*) were damaged by *Dichocrocis punctiferalis*, Guen. (Pyralidae) the larvae feeding on the seeds and pupating in the soil. The leaves of this tree were eaten by the larvae of the Noctuid *Ischyja manlia*, Cram.

A fruit fly new to the collection, *Dacus cucurbitae*, Coq. was discovered on cucumber and luffa. The eggs were inserted under the skin of the fruits, the larvae boring in all directions and spoiling the fruit for consumption. When full-grown the larvae leave the fruit and enter the soil, pupating just under the surface. This is a serious pest of cucurbits and prompt action should be taken as soon as the maggots are found. All infected fruits should be picked at once and burned.

Crucifers were damaged by several insects, notably by the Pyralids *Crocidolomia binotalis*, Zell. and *Hellula undalis*, F. the latter being rather more common. The larvae of the first-named insect eat the flowers and young shoots, while the larvae of the latter appear to feed on any portion of the plant, and on one occasion were found boring into the midribs of the leaves.

Beans were attacked by *Lamprosema indicata*, F. (Pyralidae) the larvae of which feed on the leaves, and by *Tirathaba rufivena*, Walk, the larvae of which fold the leaves and feed inside. Parasites were found to attack the larvae of both these moths. *Tirathaba rufivena* is interesting because Mr. H. W Simmonds writes me that he has reared this species from coconut spathes in Fiji, whereas the coconut Pyralid in Malaya is a species of *Tirathaba* allied to *trichogramma*, Meyr. which has not actually been determined. The two moths resemble each other somewhat, and it has been suggested that the species near *trichogramma* is merely a local race of *rufivena*, but in addition to differences in the adults the larvae are different.

Among other insects recorded during the year the following may be mentioned :—

Nygmia similis, Moore and *Nygmia* sp. No. 1057, on China-wood oil trees; *Euthalia garuda*, Moore on cashew nut; *Margaronia caesalis*, Walk on bread fruit: *Asota caricae*, Boisd. (Arctiidae) on Ngai camphor; and the coconut skipper. *Hidari thrax*, Hbn. on bamboo.

Parasites.—Control by the importation of parasites is becoming more and more general as the study of parasitism and distribution advances. Several enquiries on the parasites of various pests have been received by the Entomological Laboratory during the year, and it is thought that the publication of a note of the parasites recorded during the year would be of some interest. Malaya is very rich in insect parasites, and it is possible to obtain quantities of material which might be used elsewhere. Unfortunately the vast majority of the parasites remains unidentified, but the table given below will give some idea of the available insects of this type. Only those hosts which have been definitely identified are shown, many of the batches received having been so well parasitised that identification was not possible.

PARASITES REARED IN 1924.

Host.	Stage attacked	Record No.	Remarks.
COCCINELLIDAE —			
Chilomenes 4-plagiata, Swartz -	Pupa.	1381	Chalcidoid.
HISPINAE—			
Plesispa reichei, Chap.-	Egg.	1855	Chalcidoid. See special Bulletin No. 34.
„ *nipa*, Maulik-	„	1854	Chalcidoid.
DYNASTINAE—			
Oryctes rhinoceros, L -	Larva.	1452†	Pupal period 8 days. Sarcophagid.
„ „ -	„	1460†	Sarcophagid.
„ „ -	„	1686†	
PENTATOMIDAE—			
Scotinophara coarctata, F. -	Egg.	960	Chalcidoid See M. A. J. Vol. 12 No. 4.
Scotinophara coarctata, F. -	Nymph.	1234†	
COREIDAE—			
Leptocorisa sp. -	Egg.	1852	Chalcidoid.
„ -	„	1857	„
Leptocorisa acuta, Thunb. -	Egg.	1917	Chalcidoid.
PAPILIONIDAE—			
Papilio agamemnon, L.	Larva.	1958	112 from one larva. Braconid.
AMATHUSIIDAE—			
Discophora necho, Fldr.	Pupa.	1934	20 from one pupa. Tachinid.
Amathusia phidippus, L. -	Larva	1195	Tachinid.
HESPERIIDAE —			
Chapra mathias, F. -	Larva	1790	Tachinid. *Thelaira* sp. ?
„ „ -	„	1850	Braconid.
„ „ -	„	1935	Chalcidoid.
Hidari thrax, Hbn. -	„	958	Tachinid.
„ „ -	„	1204†	Pupal period 13 days. Sarcophagid.
Erionota thrax, L. -	„	1859	Braconid. *Apanteles* sp ?

PARASITES REARED IN 1924.—(contd.)

Host.	Stage attacked	Record No.	Remarks.
NOCTUIDAE —			
Amyna punctum, F. -	Larva.	1238	Tachinid.
Spodoptera pecten. Guen. -	Egg.	1321	Chalcidoid.
LYMANTRIIDAE—			
**Dasychira grossa*, Pag. -	Pupa.	1931	Tachinid.
Nygmia scintillans, Walk. -	Larva	1412	22 from one larva. Chalidoid. Pupal period 6 days.
Nygmia scintillans, Walk. -	,,	1418	7 from one larva. Braconid.
Nygmia scintillans, Walk. -	,,	1445	
SPHINGIDAE—			
Acherontia styx, Westw. -	Egg.	1592	69 from 3 eggs. Chalcidoid.
SATURNIIDAE —			
Attacus atlas, L. -	Egg.	1044	Chalcidoid.
,, ,, -	,,	1106	,,
,, ,, -	,,	1803	,,
PYRALIDAE—			
Psara bipunctalis, F.-	Pupa.	1591	Ichneumonid.
,, ,, -	Larva	1932	Braconid.
,, *stultalis*, Walk.-	,,	1403	48 from one larva. Braconid.
Psara submarginalis, Swnh. -	,,	1595	Adult not reared. Hymenoptera.
Lamprosema diemenalis, Guen. -	,,	914	7 to 8 from one larva. Braconid. Pupal period six days.
Lamprosema diemenalis, Guen. -	,,	1522	5 to 9 from one larva. Braconid. Pupal period 8 days.
Lamprosema diemenalis Guen. -	,,	1523	Pupal period 6 to 8 days. Braconid.
Lamprosema diemenalis, Guen. -	,,	1687	Pupal period 8 days.
Sylepta derogata, F. -	,,	1320	Chalcidoid.

PARASITES REARED IN 1924.—(contd.)

Host	Stage attacked	Record No.	Remarks.
PYRALIDE—(contd).			
Sylepta derogata, F. -	Larva.	1759	Pupal period 8 days; Braconid; hyperparasitised.
,, ,, -	,,	1908	13 from one larva. Braconid.
,, ,, -	,,	1944	10 to 11 from one larva. Braconid. Pupal period six days.
,, ,, -	,,	1951	10 to 11 from one larva. Braconid.
Caprinia conohylalis, Guen. -	,,	1708	19 from one larva. Pupal period 8 days. Braconid.
Chaphalocrocis medinalis, Guen. -	,,	966	
Tiratkaba sp. nr. trichogramma, Meyr.	,,	1483	Tachinid.
,, -	,,	1504	Ichneumonid. *Anilasta* sp.?
,, -	,,	1515	,, *Campolex* sp.?
GELECHIADAE —			
Stegasta variana, Meyr.	Larva.	1511	Adult not reared. Hymenoptera.
GRACILLARIADAE—			
Stomphastis plectica, Meyr. -	Pupa.	1542	Proctotrypid ?
LYONETIADAE —			
**Phyllocnistis citrella*, Stt. -	Pupa	1537	2 from one pupa. Chalcidoid.
**Phyllocnistis citrella*, Stt. -	,,	1538	Adult not reared. Hymenoptera.
AGROMYZIDAE-			
**Agromyza sojae*, Zehnt. -	,,	1373	Chalcidoid.
	,,	1379	

*Identification provisional only.
†Parasitism uncertain.

In addition to the above lists of parasites the following predatory insects were observed : —

The Syrphids *Ischiodon scutellaris*, F. and *Paragus serratus*, F. —the Noctuid *Eublemma rubra*, Hamps. and an unidentified Lycaenid whose larvae were predaceous on Coccids—the Coccinellids *Alesia discolor*, F., *Chilocorus politus*, Muls., *Chilomenes 4—plagiata*,

Swartz, and *Coelophora inaequalis*, F. The parasitic and predatory enemies of *Artona catoxantha* are not mentioned, being fully dealt with in another paper. The thanks of the writer are due to Dr. Guy A. K. Marshall, Director of the Imperial Bureau of Entomology, and to the Systematic Specialists of the British Museum, for the identification of species.

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PROGRESS REPORT ON A CAMPAIGN AGAINST RATS IN KRIAN DISTRICT. NOVEMBER 15th, 1924—MARCH 31, 1925.

By F. W. South and F. Birkinshaw.

On the suggestion of the Chief Secretary to Government a special campaign against rats was commenced on November 15th, 1924 in a defined portion of the irrigated padi area in Krian. This campaign had three objectives in view. It was intended to destroy as many rats as possible before the padi harvest. It was also intended to arouse among local padi cultivators a greater and more practical interest in rat destruction by demonstrating the value of concerted and sustained measures for this purpose. Finally it was expected to provide for future use information regarding the best methods of rat control.

Organisation.

Area.—The area selected for a commencement was that enclosed by the Province Wellesley boundary on the North, the Parit Buntar—Bagan Serai road on the East, the Bagan Serai- Kuala Kurau road on the South and the coast between Kuala Kurau and the Province Wellesley boundary on the West. This area is approximately 30,000 acres in extent and comprises some of the best padi land in Krian District. It is divided roughly into halves by that part of the main irrigation canal which runs somewhat diagonally northwest from Bagan Serai to Tanjong Piandang.

Staff.—Two European Special Officers were temporarily appointed for the work. Mr. Lindsay Vears was placed in charge of the area south of the main canal on November 15th and Mr. A. E. Taylor was appointed to be in charge of the area north of the canal on December 1st. Both Special Officers worked under the direction of the Agricultural Field Officer, Perak North.

Methods.—Before the campaign started the co-operation of the District Officer was obtained. He arranged for the active assistance of the Penghulus in the area and it was agreed to offer prizes to such Ketuas and others as should be recommended by the District Officer for good results obtained by their aid.

The Executive Engineer, Krian, agreed to assist by carrying out with his own staff the work of rat destruction affecting the banks of the canals and distributaries of the irrigation system. The arrangement was that the Department of Agriculture should provide the material required and, if necessary, the money for the payment of additional labour, and that officers of the Agricultural Department would demonstrate the methods to be employed.

The Special Field Officers were made responsible for encouraging and assisting all cultivators in the area under their charge to destroy

rats by the use of poisoned baits, by trapping and by organised hunting. The necessary poisons and traps were supplied by the Department of Agriculture free of charge. These officers were also instructed to arrange convenient centres at which rewards, at the rate of one cent a tail, could be paid two or three times a week for all rat tails brought in.

Experiments were to be undertaken as opportunity offered with calcium cyanide dust for the destruction of rats in holes in the banks of canals or distributaries, or in the "batas" of the padi fields or elsewhere. This powder is blown into the rat holes from a powder gun. There it evolves hydrocyanic acid gas which quickly proves fatal to any rats in the underground run. Calcium cyanide thus acts in much the same manner as does carbon bisulphide, the use of which is described in Bulletin No. 5 of the Department of Agriculture, F.M.S. Carbon bisulphide has given very satisfactory results in the past, but is now unobtainable, since shipping companies refuse to carry it because it is extremely inflammable. It is hoped, therefore, that calcium cyanide may prove a convenient substitute.

SUMMARY OF WORK DONE AND RESULTS OBTAINED.

1. *Poisons.*

(*a*) *Sodium arsenite.*—Six cwt. of this poison was supplied and was distributed to all cultivators throughout the area by the Ketuas. The common Malay method of using a dead grasshopper as bait and inserting some of this poison into its stomach proved very successful, but the quantity of grasshoppers used caused the price of the dead insects to jump from 20 to 10 cents a hundred in a very short time.

Various other mixtures were experimented with and of these the following appears to have been the most successful:—

Sodium arsenite	...	1 part by volume
Rice polishings	...	1 ,, ,, ,,
Dried fish or prawn	...	1 ,, ,, ,,

These were mixed with enough coconut oil and water to make the mixture bind. It was then rolled into small balls and placed here and there on the batas of the padi fields.

(*b*) *Barium carbonate.*—When work started no supplies of this poision were available but a consignment previously ordered arrived in January and of this 820 lb. were sent to Krian, for distribution to padi growers as required.

The use of these poisons has doubtless accounted for the death of a large number of rats, but no exact figures can be given, because in the returns of tails collected no record has been kept of the cause of death, and also because, in all probability, a certain proportion of the rats killed are not found. Cultivators are prone to be somewhat sceptical of the utility of the poisons because the dead rats are

seldom recovered by the man who puts down the poison. Both poisons are somewhat slow acting, so that the rats often run a considerable distance before they die.

(c) *Calcium cyanide.*—A supply of 20 tins each of 5lb. was obtained for killing rats in their holes. The method of using the poision has already been described. At first the necessary powder guns were not available but later one was obtained and a Malay was trained to use it. The preliminary experiments with it proved successful. In February 12 more pumps were obtained for use by the P.W.D. on the banks of the irrigation system. It was found however, that contrary to expectation, rat holes in the canal banks were not very numerous, so that opportunities for using the cyanide were limited. Further work with this poison is contemplated during the year, when a small number of Malays will be trained to use it.

2. *Traps.*—The kind of trap used was a simple form of break back trap, consisting of a wire spring mounted on wood. Four thousand of these were obtained and 500 were handed over to the Executive Engineer. Nearly the whole of the remainder were distributed free of charge to padi cultivators who have shown more interest in this method of killing rats that in any other.

3. *Organised Hunting.*—Very little use has so for been made of this method.

4. *Payment of Rewards for Tails.*—Early in the campaign it was realised that many Malay padi growers did not take kindly to the idea of bringing in rats tails for a reward. In several instances Ketuas have carefully recorded the number of rats killed by padi-growers, but have refused to present tails and claim the reward. It was felt that this reluctance to accept rewards might affect the success of the campaign. Consequently the Inspector of Schools was approached and his permission was obtained to utilise the schools for the payment of rewards for tails brought in by the scholars. This proved a success. The boys probably began by bringing in a few tails from rats caught by their fathers, but they soon began rat catching themselves, traps being supplied to the schools for this purpose. Thirteen schools assisted in this way and were responsible for 28,910 tails, a very creditable total. The valuable assistance of the masters of the schools is much appreciated by the Department. As the campaign progressed the Malays themselves became less reluctant to claim the rewards and Ketuas brought in a certain number of tails.

Results.

The destruction of rats proceeded steadily until the end of February when it practically stopped because all the available labour was fully occupied in reaping the harvest. On February 23rd Mr. A.E. Taylor resigned and it was decided not to replace him, as a revised scheme of organisation for future work based on the experience gained, was in process of formation. Mr. Lindsay Vears was left in charge of such work as could be done throughout the whole of the area during March.

The total number of rats reported as killed between November 15th 1924 and March 31st 1925 in the area of the campaign was 71,092. This was made up as follows:

Tails collected by Schools	...	28,910
Tails brought in by Ketuas	...	16,107
Tails collected by the P. W. D.	...	2,351
Rats reported killed by Ketuas	...	23,724
		71,092

The last item represents accounts kept by Ketuas of rats reported to them as killed, but for which no rewards were claimed. No reasons are, however, known for doubting the accuracy of these accounts. The total probably does not include all the rats killed by poison of which a proportion were probably not found, nor does it include litters of young that may have died after the destruction of their parents. This result was considered sufficiently satisfactory to justify the continuation of the campaign throughout the remainder of this year and its extention to include practically the whole of the irrigation area in Krian. There is little doubt that only a percentage of this number of rats would have been caught had the campaign not been inaugurated.

The campaign was started too late in the year to obtain full success in saving padi from damage, as a good deal of damage had been done to the growing crop before work started. It will be interesting to see the effect of the work done in reducing the damage to the next crop.

Apart from the number of rats destroyed, the campaign has achieved a satisfactory measure of success in its second objective, since it has undoubtedly aroused the interest of the padi growers in measures for the control of rats. It is hoped that continuation of the work will help to maintain this interest, more especially during the planting of the nurseries and the subsequent growing period of the next crop.

Valuable experience in the habits of rats and the methods of destroying them has been gained, but much remains to be learnt regarding their habits at different seasons of the year. Further experiments with different methods of trapping and poisoning will be undertaken. Special attention will be given to the use of calcium cyanide which should prove a serviceable poison, if opportunities for its use in large quantities can be found.

While this article was in preparation information was received that during the month of April the coolies employed by the P. W. D. had destroyed 16,151 rats of which the majority were caught by organised hunting.

Along the bottom of the banks of the water distributaries in Krian, between the banks themselves and the padi fields proper,

grows a strip about 6 or 8 feet wide of a rush, *Scirpus grossus* Vahl., known by the Malays as "rumput menderong." It was found that rats were sheltering in this in considerable numbers and were even building temporary nests in it. To destroy these the following method is employed. A length of about 30 yards of the rush is dealt with each time ; two or three coolies cut down all the weeds giving cover along the bank of the distributory, while two or three more coolies cut away the weeds in the padi field on the other side of the belt of rushes, so as to clear the land for a width of about 12 feet. After the cutting has started at the sides, one cooly at each end commences to cut the menderong itself. In this way the rats are driven along the belt of menderong, until only a small patch of cover is left. When the rats finally attempt to leave the cover they are killed by the coolies. Only a very few manage to escape. The coolies receive the usual reward of 1 cent per tail in addition to their wages.

This method is not so expensive as it might seem, because the weeds along the banks of the distributaries have to be cut in any case.

The method is rendered far more successful when the work of the coolies is properly organised and the Agricultural Department is much indebted to Mr. Grantham, Assistant Engineer Krian, for the attention he has given to this important point and the interest he has taken in the work.

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MARKETING ROSELLE.

As the cultivation of roselle in this country has been neglected of late, attention should be drawn to the fact that certain manufacturers both in the United Kingdom and America have of late addressed this Department on the subject of supplies of the fibre, shewing that they were anxious to know the possibilities of obtaining regular supplies and being placed in touch with growers.

The earlier attempts to cultivate this crop on a profitable basis did not meet with success in many cases, but at least two planters went so far as to manufacture rope and string which they found no difficulty in disposing of locally, and obtaining a fair profit. This method may be recommended when roselle is grown as a catch crop in young rubber, as was the case in the two above mentioned instances; but if the European or American markets are to be supplied, it is essential that a guarantee of supplies be forthcoming, and it is doubtful whether successful connections with manufacturers will be established unless this is done. The attitude of the planter has been that he required a guaranteed market over a period; of the manufacturer, that he required a guaranteed output—and a considerable one too—before he could consider the possibilities of using roselle. Between these two views, the cultivation of roselle languished and has practically died out.

The fact that manufacturers are interesting themselves in roselle is probably due to the continued rise in price of jute; and the time seems opportune for action, if roselle is to be established as an industry in Malaya, to place growers and manufacturers in touch on this subject.

From correspondence received from manufacturers, the use of roselle is placed in competition with Jute. The London price of jute on January 28th last for "Native First Mark" quality was £38-15-0 per ton. The total outturn of jute in British India in the season 1924 is estimated at 8,045,000 bales of 400 lbs. as against 8,472,000 bales (revised) in 1923 (including imports from Nepal).

Two samples of yarn prepared by a well known firm of Dundee manufacturers have recently been received by the Department. Sample No. 1 was made entirely of roselle fibre; sample No. 2 from three-quarters jute and one quarter roselle fibre. The firm in question comment as follows on these samples.

> "The quality of No. 1. though very hairy, is clean and strong and inclined to be brittle.. If this yarn was twisted in two or three ply, it would be extremely strong. It did not work well on the preparing machinery, being so strong and harsh it did not draw well, and was inclined to choke on the drawings. If it was a case of working in bulk, the preparing machinery could be altered to get over this to a large extent. I should think this would be a valuable fibre to anyone making twines.

In the No. 2 sample we found that this fibre did not blend very well with the jute In the preparing, the jute was drawn easily while the fibre held and this, of course did not make level yarn, but if the price was sufficiently low it might tempt one to make further experiments in this line."

They conclude by stating that they would be glad to receive an offer of about five tons, so that they could really have a chance of experimenting.

A London firm to whom the Department of Agriculture forwarded a sample of roselle fibre grown on the Government plantations state that the fibre is not well introduced in London, and such being the case they would be pleased to receive small consignments of 5 to 10 tons, so that they can get it introduced to their various buyers ; and later they could probably arrange to give definite firm orders for a larger quantity spread over 3 to 6 months in advance.

In a previous communication, this Department had pointed out that growers were reluctant to cultivate roselle as they had been unable to obtain forward orders over a period of one or two years, but if this could be arranged, it was possible that planters would cultivate the crop.

In reply, the firm in question state :—

" We do not think that buyers will entertain placing an order for one or two years, in view of the somewhat violent fluctuations that have taken place recently in hemps and fibres of this description. The fibre should, however, fetch £25 to £30 per ton c.i.f. United Kingdom and naturally, if the market is better, it will probably fetch more, but we think this is a fairly stable market value on which you could rely.

The fibre should be pressed in bales, 3 to 4 cwt. each would be a suitable size, or not less than 2 cwt. if your presses are smaller."

The Department of Agriculture will be pleased to give further details on application, of such correspondence as has been received.

D. H. G.

Received for publication 12th May 1925.

PRICE LIST OF PLANTING MATERIAL OBTAINABLE FROM THE DEPARTMENT OF AGRICULTURE, F.M.S. & S.S.

THE undermentioned planting material is produced mainly at the Experimental Plantation, Sardang, and small stocks of such material are usually available for sale.

A register of growers who are able to supply large quantities of any particular material is kept in the Agriculturist's Office with the object of placing purchasers in touch with sources of supply.

Orders for planting material should be addressed to the Agriculturist, F.M.S. & S.S., Kuala Lumpur, and should be accompanied by a remittance to cover the material ordered.

It is advisable in the first instance that applicants for planting material enquire from the Agriculturist whether the material required is in stock before forwarding a remittance.

With a view to expediting the execution of orders, applicants are particularly requested to state their requirements in a separate letter and not to include them in correspondence dealing with other subjects.

The prices quoted below include packing charges and freight from Kuala Lumpur to any station on the Federated Malay States Railways.

B. B.

A. AGRICULTURAL PLANTS.

FOOD CROPS.

Cow Pea	-	seed 50 cents per lb.
Maize	-	,, 20 ,, ,,
Pigeon Pea	-	,, 50 ,, ,,
Sweet Potatoes—		
Local	-	cuttings $1/- per 100
Gedang	-	,, ,,
New Jersey Red	-	,, ,,
Menesbodas	-	,, ,,
North No 3	-	,, ,,
Samar Big Yellow	-	,, ,,
Samarinda	-	,, ,,
Southern Queen	-	,, ,,
Victoria.	-	,, ,,
Sugar Canes—		
Malayan varieties	-	cuttings $2/- per 100
Java ,,	-	,, ,,

Tapioca—

Local White	- cuttings	$1/-	per 100
,, Green	- ,,		,,
Aipin Valenca	- ,,		,,
,, Mangi	- ,,		,,
Kapo	- ,,		,,
Mandioca Basioras	- ,,		,,
,, Creolinha	- ,,		,,
,, Sao Pedro Treto	- ,,		,,
Manis	- ,,		,,
Sipin Mangi.	- ,,		,,

Yams—

Greater	- tubers	25 cents	per lb.
Lesser.	- ,,	,,	,,

FRUITS.

Avocado Pear	- seedlings in bamboo pots	.40	cents	each.
Bananas (varieties)	- suckers	.25	,,	,,
Blimbing	- seedlings in bamboo pots	.40	,,	,,
Brazil Cherry	- ,, ,,	.40	,,	,,
Brazil Nut	- ,, ,,	.40	,,	,,
Bullock's Heart	- ,, ,,	.40	,,	,,
Carambola	- ,, ,,	.40	,,	,,
Chiku	- ,, ,,	.40	,,	,,
Durian	- ,, ,,	.40	,,	,,
Guava	- ,, ,,	.40	,,	,,
Jack Fruit	- ,, ,,	.40	,,	,,
Lemon	- ,, ,,	.40	,,	,,
Lime	- ,, ,,	.40	,,	,,
Malay Apple	- ,, ,,	.40	,,	,,
Mangosteen	- ,, ,,	.40	,,	,,
Orange	- ,, ,,	.40	,,	,,
Pineapples (varieties)	- suckers	.10	,,	,,
Pomelo	- seedlings in bamboo pots	.40	,,	,,
Pulasan	- ,, ,,	.40	,,	,,
Rambai	- ,, ,,	.40	,,	,,
Rambutan	- ,, ,,	.40	,,	,,
Ramnia	- ,, ,,	.40	,,	,,
Rokam	- ,, ,,	.40	,,	,,
Soursop	- ,, ,,	.40	,,	,,
Sugar Apple	- ,, ,,	.40	,,	,,
Tamarind	- ,, ,,	.40	,,	,,
Water Lemon (Passiflora laurifolia)	- ,, ,,	.40	,,	,,

BEVERAGES.

Coffee (varieties)—

Liberian	- seed	$1/-	per lb.
Robusta.	- ,,	,,	,,

Fixed Oils and Fats.

African Oil Palm	-	seed $5/- per 1000
,, ,,	-	seedlings .25 cents each
Castor Oil	-	seed .50 ,, per lb.
Gingelly	-	,, .50 ,, ,,
Groundnuts (varieties)	-	,, .20 ,, ,,

Essential Oils.

Citronella Grass	-	cuttings $2.50 per 1000
Geranium ,,	-	,, $2.50 ,,
Lemon ,,	-	,, $2 50 ,,
Patchouli ,,	-	plants $10/- per 100
Vetiver ,,	-	cuttings $2.50 ,, 1000

Fibre Plants.

Bimlipatam Jute	-	seed $1/- per lb.
Kapok	-	,, .25 cents per lb.
Manila Hemp	-	suckers .20 ,, each
Mauritius Hemp	-	bulbils $1/- per 100
,, ,,	-	suckers $2/- ,,
Roselle Fibre	-	seed $1/- per lb.
Sisal Hemp	-	bulbils $1/- ,, 100
,,	-	suckers $2/- ,, ,,

Drugs.

Ipecacuanha	-	cuttings .10 cents each.
,,	-	plants .40 ,, ,,

Spices.

Pepper	-	plants .20 cents each.
Vanilla	-	cuttings .10 ,, ,,

Dyestuffs & Tanning Materials.

Annatto	-	seed $1/- per lb.
Gambier	-	,, $1/- ,,

Fodder Grasses.

Australian Blue Couch	-	cuttings $2.50 per bag.
Bermuda Grass	-	,, 1.50 ,,
Carpet Grass	-	,, 1.50 ,,
Dallis Grass	-	,, 1.50 ,,
Guinea Grass	-	,, 2.50 per 1000
Mauritius Grass	-	,, 2.50 per 1000
Napier Grass	-	,, 2.50 per 1000

Cover Crops.

Calopogonium mucunoides	-	seed .50 cents per lb.
Canavalia ensiformis	-	,, .50 ,, ,,

COVER CROPS—*(contd)*.

Centrosema Plumieri	-	seed .20 cents per lb
,, pubescens	-	,, .50 ,, ,,
Crotalaria anagyroides	-	,, .50 ,, ,,
,, usaramoensis	-	,, .50 ,, ,,
Mimosa invisa	-	,, .50 ,, ,,
Tephrosia candida (Boga Medeloa)	-	,, .50 ,, ,,
,, Hookeriana var. amoena	-	,, .50 ,, ,,
Vigna oligosperma	-	cuttings $1.50 per bag.

ORNAMENTAL AND SHADE TREES.

Casuarina equisetifolia	-	plants .40 cents each.
Cassia grandis	-	,, .40 ,, ,,
,, multijuga	-	,, .40 ,, ,,
Jacaranda	-	,, .40 ,, ,,
Peltophorum ferrugineum	-	,, .40 ,, ,,
Poinciana regia	-	,, .40 ,, ,,
Rain Tree	-	,, 40 ,, ,,
Spathodea campanulata	-	,, .40 ,, ,,

B. HORTICULTURAL PLANTS.

Shrubs (*a*) bushes	-	plants .25 cents each.
(*b*) standards	-	,, .50 ,, ,,
Climbers	-	,, .25 ,, ,,
Palms	-	,, .50 ,, ,,
Ferns	-	,, .50 ,, ,,
Cannas (varieties)	-	roots .10 ,, ,,
Flower Seeds Vegetable Seeds	- -	Arrangements have been made with Messrs John Little & Co., Ltd., Kuala Lumpur for the distribution of these seeds, to whom all applications for same should be sent direct.

Planting material other than that mentioned in this list will be quoted on application, providing material is available for distribution.

Received for publication, 31st May, 1925.

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture: and the Malay States Information Agency, 88, Cannon Street, E C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV	(1913-16) VIII & IX (1920-21)		price	$5.00 per volume.
Vol. V	(1917)	Nos. 1, 2, 3, 5 & 6	„	2.50 per set.
„ VI	(1918)	„ 1, 7, 8 & 12	„	2.00 „
„ VII	(1919)	„ 2—6	„	4.50 „

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

Vol. X (1922)	Price $5.00 per volume.
„ XI (1923)	Price $5.00 per volume or 50 cents per single number.
„ XII (1924)	„ „ „ „

Back numbers of Vols. I—X will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased at the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co.

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, Government Entomologist, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher.
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, Government Entomologist, 1910, reprint 1916, 20 cts. (Out of Print.)
4. A Lepidopterous Pest of Coconuts, *Brachartona catoxantha, Hamps*, by H. C. Pratt, 1909.
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909.
6. Preliminary note on a Branch and Stem Disease of *Hevea Brasilienisis*, by W. J. Gallagher, 1909.
7. Coffea Robusta, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910.
9. Die-Back Fungus of Para Rubber and of Cacao, by K. Bancroft, 1911.
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher, 1910.
11. Coconut Cultivation, by L. C. Brown, 1911.
12. Padi Cultivation in Krian, by H. C. Pratt, 1911.
13. A Root Disease of Para Rubber, *Fomes Semitostus*, by K. Bancroft, Assistant Mycologist 1912, 20 cts.

C = Cancelled

THE

Malayan Agricultural Journal.

Vol. XIII.] JULY, 1925. [No. 7.

ANNUAL REPORT OF THE CHEMICAL DIVISION FOR 1924.

By B. J. Eaton.

Staff.

The staff of the Division consisted of the following officers :—

Agricultural Chemist	...	B. J. Eaton.
Asst. Agrl. Chemists	...	R. O. Bishop, C. D. V. Georgi, V. R. Greenstreet, J. H. Dennett.
Asst. Analyst	...	Gunn Lay Teik.

The Agricultural Chemist was on service leave from the 26th April, till the end of the year, Mr. R. O. Bishop was on leave from the beginning of the year until 7th May. Major C. D. V. Georgi acted as Agricultural Chemist from the 27th April till the 8th May when, Mr. R. O. Bishop returned from leave and assumed duties as Acting Agricultural Chemist.

Mr J. H. Dennett proceeded to Sandakan, British North Borneo on the 19th December in order to see and report on the production of power alcohol (alcohol-ether mixture) from the juice of the Nipah palm.

Organisation.

The Agricultural Chemist, in addition to administration duties, has been responsible for all reports and general supervision of all investigations carried out by the Assistant Agricultural Chemists. Special research investigations have been divided between the different officers as far as possible, so that one or more investigations are entirely undertaken by each individual officer. The special investigations completed or on hand during the year have been divided as follows:—

(1) Investigations on rubber and fibre.

(2) Investigations on guttapercha, nipah palm and the tapioca plant.

(3) Investigations on oils and fats and various indigenous forest products.

(4) Investigations on soils, fertilisers and jelutong.

In addition to the research work carried out during the year a number of miscellaneous routine analyses have been carried out, including some hundreds of samples of latex, which were examined on behalf of the United States Rubber Plantations and various estates from which this company was purchasing latex.

Details of the various researches and analyses undertaken are summarised briefly below in connection with the individual products under investigation.

Much time was devoted to the preparation and collection of samples and photographs of various agricultural products for the Agricultural Section of the Malaya Pavilion, British Empire Exhibition.

Rubber Research and Investigations.

Special researches on rubber problems have again been curtailed considerably on account of the amount of time which has had to be devoted to problems on other products and also investigations on dry rubber content and ammonia content of preserved latex which have been made in connection with the purchase of latex from various estates and its export from Malaya. Until the end of July the Chemical Division acted as referees or arbitrators. A large amount of valuable data has been collected in respect of the dry rubber content of latex from month to month and it is interesting to note that the average dry rubber content for the seven months' period is only a fraction above the standard for export of latex laid down by the Government during the year viz. 3·5 lbs. of dry rubber per gallon of latex. Interesting fluctuations in the concentration of the latex are also noted after resting periods and when new cuts are opened. The results confirm work previously published by other investigators. The figures also indicate that any mature estate can maintain this standard, provided the tapping and collection is controlled, so that the coolies do not add water to the latex in the field.

Latex samples to the number of 2864 were examined during the period of seven months to the end of July. These include the following determina- tions:—Total solids in 177 samples, dry rubber content in 2864 samples and ammonia content in 177 samples of latex and 18 samples of ammonia solution.

Since the "Dry rubber content" (i. e. commercial rubber) of latex is not a definite chemical entity and may vary according to the method of coagulation employed, experiments have been commenced to determine the variations, especially in the case of latex preserved with ammonia.

Further investigations on S. I. P. E. F. cured rubber were carried out, but could not be continued to completion, since the estates preparing this grade of rubber accepted contracts for the sale of the whole of their crop as latex.

This type of rubber, which resembles the "slab" rubber (matured coagulum), first prepared by this Department, but converted to dry crepe after maturation, was finding a ready sale at a slight premium among certain buyers in America. It is of interest to note that the cost of preparing the raw product is less than that of other first grade rubbers viz. smoked sheet and pale crepe, while the "lump" rubber from field coagulation can be added to the rubber and legitimately incorporated as first grade, since the appearance of the rubber is streaky and is no criterion of its intrinsic quality.

Investigations also showed the advantage of a moisture saturated atmosphere in the preparation of "slab" rubber.

Samples of crepe rubber, containing various dyes and pigments, used for the manufacture of coloured crepe mats, were vulcanised by the sulphur chloride cold-cure process for an estate and gave satisfactory results. The sulphur chloride was used in a carbon-tetrachloride solution, which appears to be a satisfactory substitute for carbon disulphide and not so dangerous or unpleasant.

Experiments on the cold storage of raw crepe mats and also similar mats containing loading material in the form of pigments etc. showed that these mats become very hard and stiff during cold weather and liable to crack at the joints of the various coloured pieces used in the design. This was also noted by the writer in the case of similar mats made in Malaya and Ceylon, which were being sold by a firm in the Malaya Pavilion at the British Empire Exhibition, Wembley.

This effect of climate may not be of much importance when these mats are used in warm houses, but is an important factor in the use of such mats in motor cars during cold weather.

Owing to the operation of the Rubber Restriction and Customs Enactment, it was found necessary to determine the rubber content of rubber articles manufactured in the Federated Malay States for export. As is well known the difficulties involved in such an estimation are considerable, owing to the variety and nature of the inorganic or organic compounds now used in different articles. Since it was found impossible to carry out these determinations in a reasonable period, on the recommendations of the Acting Agricultural Chemist it was decided to grade the various locally manufactured rubber articles, according to their average rubber contents. The Agricultural Chemist has acted as adviser to the Customs Department in connection with the definition of manufactured articles for export.

An investigation on the quality of rubber from latex after various resting periods was carried out and confirmed results obtained previously by other investigators. The results of this investigation will be published in the M.A J. In connection with routine investigations on rubber samples, the principal enquiries have been concerned with defects in smoked sheet such as bubbles and "rust."

Latex paper :—Investigations on the quality of certain latex papers were commenced and completed. The results of the investigation, especially in connection with ageing of these papers do not

appear to indicate any advantage from their use, unless the paper can be purchased more cheaply than non-latex paper: A detailed report of this investigation is being prepared for publication in the M.A J.

Rubber oil:—Considerable local interest has been taken in connection with the oil prepared by the dry or destructive distillation of lower grade rubbers, owing to the work which was commenced on an estate in Perak The Chemical Division has indicated that there is nothing essentially new or novel in the process, since the investigation of the oil obtained by this method had been carried out many years ago by various chemists of repute in Great Britain and elsewhere. On this account an application for a patent for the process was refused in this country. At the same time there may be certain applications for such an oil or for certain fractions of such an oil, provided the cost of the raw material (lower grade rubber-scrap etc.) is nil or very low and the cost of distillation not high. The oil may be a useful product for internal combustion engines but it must be remembered that petrol, even in Malaya, where the price is high, costs about 1d. per lb. and one pound of rubber, even at maximum efficiency, can only produce 1 lb. of oil and is likely to produce less. The specific gravity of the oil is probably higher than that of petrol, so that assuming it to be 0 800, it will require at least 8 lbs. of rubber to produce a gallon of oil. Such an oil may have other uses as a solvent or for medicinal purposes, as a vehicle for paints, varnishes etc., but will have to compete with other cheap oils.

A large number of samples of latex, rubber in different stages of preparation, estate samples of block, slab, smoked sheet, pale crepe and sole crepe, rubber mats and other articles made from raw rubber were prepared and collected for the Malaya Pavilion, British Empire Exhibition. The tapping of a rubber tree, which was arranged by this Division, attracted considerable attention and interest in the Malaya Pavilion.

GUTTAPERCHA.

Investigations on the mechanical extraction of guttapercha from the leaf were continued and completed. A satisfactory method, which resembles that used in Java and also in Malaya was devised. A report on this work will be prepared for publication in the M.A.J. The investigation was of considerable interest as a problem in grinding material of this kind, since it was found that the method of grinding is of great importance as far as the yield of guttapercha is concerned. The samples of guttapercha were of good quality and contained a low percentage of dirt and fibre.

JELUTONG.

Considerable interest has been taken in jelutong, for export to the U S.A. where it is used, mixed with chicle gum, derived from South America, as the principal constituent of chewing gum.

Investigations on the methods of coagulation and preparation, the determination of the moisture content and the keeping qualities of samples prepared in different ways have been carried out

during the year and two reports published in the M.A.J. Samples of coagulants containing "preserving" agents have also been examined. Advice has also been given to manufacturers of jelutong and consultations have been arranged with buyers in Singapore.

Oils and Fats.

The following samples of various fats and oils and raw products yielding oils and fats have been investigated. Borneo tallow (illipe fat), ground nut oil, rubber seed oil, desiccated coconut, copra, coconut oil and copra cake. The quality of the locally manufactured coconut oils is high and the free fatty acid content is low.

Two samples of Nyireh fruit (*N. batu* and *N. bunga*) were examined for the Forestry Department and found to contain no oil.

Palm oil:—At the request of the Honourable The Chief Secretary, experiments were carried out to determine whether more palm oil could be extracted from the residual pericarp after this has been treated by the primitive methods at present in use in Malaya and Sumatra. This residue contains about 25 per cent. of oil and it was found that 5 per cent, based on the weight of the material, could be obtained by boiling the pericarp with water and subsequent pressing in a hand-screw press. Modern machinery for the extraction of the oil with a resulting higher yield of oil, has since been installed.

Experiments on the bleaching of palm oil, in order to render it suitable for edible purposes for local use, have been commenced and are being continued. Sun bleaching has been found effective but slow. A good but slightly brown-coloured oil has also been obtained by heating the oil for a short time at 240°C. Chemical methods are also being tried, although it is considered undesirable to employ these. It is interesting to note that the oil thickens considerably on bleaching and resembles lard in consistency. A report on the manufacture of soap from palm oil was sent to one estate.

Coconut oil:—An investigation of the moisture and oil content of the "meat" from nuts from a number of high yielding coconut palms is being carried out for the Economic Botanist. The moisture content of 72 samples and the oil content of 18 samples have already been determined. The full report of this work will be published when the investigation has been completed.

A report on the origin and production of Neem Oil or Fat was forwarded to an enquirer. A larger number of samples of vegetable oils was prepared and sent to the Malaya Pavilion, British Empire Exhibition.

Essential or Volatile Oils.

An investigation of the oil content of Lemon grass at the Experimental Plantation, Serdang has been carried out. The oil was found to contain 75 per cent. of citral, which is normal. The results of this investigation were published in the M.A.J. One sample of distilled oil of limes was investigated. Five samples of Patchouli oil were examined in connection with visits paid to two essential oil

distilleries in Johore and Singapore. An article on the cultivation of Patchouli and distillation of the oil was also published in the M.A.J.

Distillations of Vetiver grass roots from the Experimental Plantation Serdang were made and the character of the oil determined. Samples of the oil were submitted to the Imperial Institute, through the Malay States Information Agency, and a report was prepared and published in the M. A. J.

A series of distillations of citronella grass from an estate in Selangor were made and the oil examined.

Experimental distillation of the leaves and twigs of the Borneo Camphor tree (*Dryabalonops aromatica*) were carried out and confirmed earlier work carried out by the writer in 1912. No oil or borneol was obtained. The wood of this tree was also distilled and the oil content found to be negligible.

It has been noted previously that this tree yields pure crystals of borneol, an oil consisting chiefly of terpenes and a white resin. The borneol occurs in cavities only in certain trees. An enquiry from a British firm interested in obtaining borneol from this source for the manufacture of synthetic camphor was dealt with both here and at the British Empire Exhibition by the writer. A sample of Pandan leaves (*Pandanus* sp) was distilled but yielded no essential oil. It is used locally for flavouring purposes.

Samples of various essential oils were supplied to the Rubber Growers' Association for exhibition at the International Rubber and Allied Tropical Products Exhibition held in Brussels in April.

A large number of samples were prepared and sent to the Malaya Pavilion, British Empire Exhibition, Wembley.

An article on the present position in respect of the production of essential oils in Malaya was prepared and sent to the Research Chemist of Messrs. Stafford, Allen & Co., for publication in a new book on the production of essential oils in the Empire.

Gums and Resins.

A report containing observations and recommendations in connection with the collection of Damar minyak, examined at the Imperial Institute was forwarded to the Conservator of Forests.

A preliminary report on a sample of "Malau", an exudation resembling lac, produced by certain insects from local forest trees has been forwarded to the Conservator of Forests and work on this product is being continued.

A report on the production of Carnauba wax was forwarded to an enquirer.

comprised both Manurial Experiments and tests of selected Radins. The results of the manurial experiments will not be available for some years, but the tests show that Radin No. 7 is well suited to parts of the Province and that Radin No. 13 is the best strain for conditions similar to those at Talang.

The experiments for restoring the fertility of reslimed mining land and rendering it fit for padi cultivation were continued during the year on the plots near Taiping and Batu Gajah. The four green dressing crops, *Tephrosia candida*, *Crotalaria usaramoesis*, *C. striata* and *Mimosa invisa* again grew well. *Tephrosia candida* grows slowly at first but later develops into a sturdy shrub which stands cutting back and thus is able to give a periodic supply of material for mulching. It yields little seed as the fruits are attacked by insects. Both Crotalarias make rapid growth. They both seed freely and the self sown seeds of both species germinate and grow, though at Batu Gajah it was found that this natural resowing was not sufficient to re-establish the crop satisfactorily without a little cultivation and artificial resowing. Neither plant will stand cutting back and neither is perennial. *Crotalaria usaramoesis* is the better of the two as it grows more luxuriantly. *Mimosa invisa* was found to make very good growth, especially on the plot at Kamunting, but is considered unsuitable, as its prickles and straggling habit render it difficult to clear off the land without burning and therefore inconvenient to dig in as manure. There is a danger too that it may spread unduly and become a nuisance in places where it is not required. It has been found that its fruits have been carried by running water and have given rise to plants at some distance from the original plot. More extensive experiments with crops that have proved useful are contemplated in the coming year. (M. A. J Vol. XII. No. 8. p 237.)

4. *Fruit.*

The fruit crops in Penang and Province Wellesley were good in the first half of the year, but became poor in the second half. Throughout the Federated Malay States and Malacca the crops were on the whole poor and in many places there was no definite fruit season such as is usual. In Johore there was a good crop of Durians in Muar district, but the crops were not so good elsewhere.

The fruit supply of the country is certainly not equal to the demand. This is particularly noticeable in Pahang where the supply is very limited and the prices are in consequence high. A considerable proportion of the fruit crop of the southern part of the Peninsula is exported to Singapore, so that even during the season, the markets of such towns as Malacca are poorly supplied with fruit, unless the crops are unusually good.

The Field Division has plans in view for establishing a few small fruit nurseries from which to distribute free good planting material, with a view to stimulating interest in fruit growing and increasing supplies.

Pineapples.—Klang District of Selangor, the southern part of Johore and Singapore island are still the chief centres of pineapple cultivation for canning purposes. The Agricultural Field Officer, Selangor, reports that the total area planted with pineapples in Klang District is estimated at 1,170 acres (estates 268 acres, small holdings 902 acres.) The approximate yield was 428,000 pines for which prices varied from $2 to 2.50 per hundred. A considerable portion of the crop was exported to Singapore.

The Inspector of Agriculture, Johore, reports a continued increase in the canning industry. Six factories were in operation, four in Johore Bharu, one in Kota Tinggi and one in Kubub. The export amounted to 409,142 cases of preserved pines, an increase of over 100,000 cases as compared with the export of 1923. The export figures for 1922, 1923 and 1924 represent about 13,500,000, 32,000,000 and 50,000,000 fruits respectively. A conservative estimate of the area required to supply the fruits in 1924 is 10,000 acres. The price of fruit at the factories has varied from $2.50 to $4 50 per 100 according to season and size. Comparatively large areas of this crop continue to be opened up, rubber being usually interplanted as a permanent crop.

5. *Other Crops.*

Nutmegs and Cloves.

Vigorous encouragement by the District Officer, Balik Pulau, with the co-operation of Agricultural Officers has brought about a revival of interest in these spice crops which were at one time valuable exports from Penang and the Province. The measures taken have been :—

(i) The reassessment at a lower rate of rubber land partly planted with spices, even if part of the rubber has to be cut out to make room for the cloves and nutmegs. This has added about 4C acres to the area planted with spices in Balik Pulau District.

(ii) Co-operation among growers for grading and marketing their produce.

(iii) Attention to cultivation and experiments for the treatment the of the pests have been largely responsible for the decline of the spice industry in the past.

All these measures have met with some degrees of success. The export of cloves has increased in spite of a gradual fall in price, while the increase in the value of mace and nutmegs has assisted the increase in production.

African Oil Palm.—The prospects for this crop are at present very satisfactory. The yields obtained on the one Estate at present in bearing have been up to expectations, although only a small portion of the estate is yet in full bearing. The growth obtained on other properties not yet in bearing has been quite satisfactory. Only about

Illipe Nuts and Borneo Tallow by C. D. V. Georgi, M.A.J., Vol. XII, No. 3.

Lemon Grass Oil by C. D. V. Georgi, M.A.J., Vol. XII, No. 3.

Cashew Nut Oil „ „ „ Vol. XII, No. 4.

Patchouli Oil by B. J. Eaton and C. D. V. Georgi, M.A.J., Vol. XII, No. 3.

Vetiver Oil by C. D. V. Georgi, M.A.J., Vol. XII, Nos. 6-7.

Notes on the uses of Raw Rubber by B. J. Eaton and J. H. Dennett, M.A.J., Vol. XII, No. 5.

Papain by B. J. Eaton, M.A.J., Vol. XII, No. 5.

The Utilisation and Waste of Wood in the preparation and packing of rubber by B. J. Eaton, M.A.J., Vol. XII, Nos. 6--7.

The Toxic properties of the Lima Bean by V. R. Greenstreet, M.A.J., Vol. XII, No. 4.

Further report on Nipah Palm by B. J Eaton and J. H. Dennett, M.A.J., Vol. XII Nos. 6--7.

The Oil Palm in Malaya by C. D. V. Georgi and B. Bunting, M.A.J., Vol. XII, Nos. 6 and 7.

Market Price Lists, M.A.J., Vol. XII, Nos. 4, 6 and 7.

Coconut Palm Products and their uses by C. D. V Georgi and B. Bunting, " The Planter ".

Potential Agricultural Industries of Malaya by C. D. V. Georgi and B. Bunting, " The Planter ".

Sisal Hemp by R. O. Bishop, H. W. Jack and J. N. Milsum, M.A.J., Vol. XII, No. 11.

Annual Report of Agricultural Chemist 1923, Vol. XII, No. 8.

Recent Development in Oil Palm Machinery by B. J. Eaton, M.A.J., Vol. XII, No. 12.

Views on the Preparation of Plantation Para Rubber by B. J. Eaton, India Rubber Journal, Vol. XLVIII, No. 5, 1924:

CONFERENCES, EXHIBITIONS AND LECTURES.

The Agricultural Chemist was on duty for two months in the Agricultural Section of the Malayan Pavilion, British Empire Exhibition and dealt with a number of enquiries.

He also paid visits to the following :—

(*a*) The Leather Trade and Boot and Shoe Exhibition in London in connection with use of sole crepe.

(*b*) Two visits to the Rothamsted Experiment Station, in connection with general matters and the investigation of Tuba Root.

(*c*) The Agricultural Development Company's Laboratories, Harpenden, in connection with the manufacture of synthetic farmyard manure.

(*d*) S. F. Edge's Piggeries. Ditchling. Sussex.

(*e*) The Imperial Institute.

(*f*) Cooper's Technical Bureau in connection with the use of Tuba root.

(*g*) The Chemical and Biochemical Laboratories. Cambridge University.

(*h*) Stafford Allen and Company's Laboratories and offices.

The following conferences were also attended (*a*) Imperial Botanical Conference (*b*) Conference at Colonial Office in connection with the recruitment, appointment, and training of Agricultural Officers, as representative for British Malaya.

(*c*) Conference of Rubber Manufacturers, Chemists etc., arranged by the Rubber Growers' Association and the Research Association of British Tyre and Rubber Manufacturers at which he read a short paper on the Preparation of Rubber.

(*d*) Conference arranged by London Chamber of Commerce on "Leather and Rubber" at British Empire Exhibition, as representative of Malaya.

A lecture on "Research on the Plantation" was also read before the Institution for Rubber Industry, London, and two lectures were given in Taiping and Ipoh, on "New Uses of Rubber".

The following papers were also read at the conference of the Incorporated Society of Planters at Kuala Lumpur.

"New uses for Rubber and new methods of preparation and vulcanisation" by R. O. Bishop.

"Potential Agricultural Industries in Malaya" by C. D. V. Georgi, B. Bunting and Milsum.

"Malayan Soils with references to Rubber and Coconuts" by V. R. Greenstreet.

"Functions of Chemistry in Agriculture" by J. H. Dennett.

A paper on "Naturally occurring fertilisers" was read by Mr. V. R. Greenstreet at the Conference of Malay Officers of the Department.

ANNUAL REPORT OF THE CHIEF FIELD OFFICER, 1924.

By F. W. South.

I. Staff.

THERE were numerous changes among European Officers and difficulties were temporarily experienced in keeping the Senior appointments filled and maintaining efficient supervision. Action has been taken to improve the situation during the coming year.

There were also several changes among Malay Officers, mainly necessitated by training arrangements. The recruiting of Malay Officers was satisfactory for the year, though the whole division is suffering from a shortage of trained officers caused by the necessity for economy in the years 1921 and 1922.

II. Estates Visited.

The following table shows the total number of estates visited throughout the Federated Malay States, the Straits Settlements and Johore :—

Area.	Estates Visited.	Visited by request.	Visited more than once.
Penang & P. Wellesley -	12	4	1
Perak North -	13	4	2
Perak South -	29	17	9
Selangor -	31	16	9
Negri Sembilan -	28	Not recorded.	5
Pahang West -	5	1	—
Pahang East -	5	4	—
Malacca -	15	14	5
Johore -	46	18	13
Singapore -	3	—	1
Additional visits by the Chief Agricultural Inspector-	11	7	—
Totals -	201	85	45

The totals include several other visits by the Chief Agricultural Inspector made in company with the Assistant Agricultural Inspector for the area in which each estate is and consequently entered under that area. The total of 201 estates visited in 1924 compares with a

total of 270 in 1923 and 326 in 1922. The very large majority of these visits were to advise on the control of diseases or pests of rubber, coconuts or fruit trees, but some were to give more general advice regarding budgrafting of rubber and the cultivation of Oil Palm, Coconuts, Coffee and one or two other plants. Advice was also sought regarding cover crops, methods of restoring badly washed soil and manuring of poor soils.

III. Notes on General Agriculture.

1. *Rubber.*

When the year opened the price of standard rubber sheet was about 49 cents per lb., but it fell steadily to about 34 cents, the lowest price being about 31½ cents in May. After the end of July there was a steady rise in price to about 68 cents per lb. in December. The steady rise was accompanied by a regular monthly decrease in the stocks in the United Kingdom which stood at 32,376 tons at the close of the year. On January 1st 1924 the stocks in the United Kingdom were 66,563 tons. Consequently 34,187 tons have been absorbed during the year in the United Kingdom, while in the same period 19,010 tons have been absorbed in the United States. The absorption of these stocks, inspite of an increase in production in the Dutch East Indies, indicates a considerable increase in the worlds consumption of rubber during 1924 and shows that the consumption was in excess of restricted production. The London stocks are now reduced to what is probably a normal quantity, so that they can no longer exercise an artificial depressing effect on prices; consumption is expected to increase steadily during the next few years, while at the same time the rate of increase of more that half of the production is controlled not only by restriction, but also to some extent by the available labour supply. Consequently the condition of the rubber producing industry appears healthier than it has done at any time in the last four years.

The average price realised has been sufficient to provide for the maintenance of estates, in good order and to allow of continued interest in problems of soil conservation and the improvement of poor land.

Enforced restriction has resulted in economy of bark consumption. This has been effected by resting areas of old trees heavily tapped in the past and areas where a comparatively poor soil has caused slow renewal of bark, by postponing the tapping of young areas, and by introducing more conservative tapping systems in practically all producing fields. The result is that there are now in the Peninsula better reserves of good tappable bark than there have been at any time since the larger part of the area planted was first brought into tapping.

Table I shows the stocks in tons in the United Kingdom on December 31st of each of the three years given.

TABLE I.*

Year.	London.	Liverpool.	Total.
1922 ...	72,299	8,782	81,081
1923 .	59,981	6,582	66,563
1924 ...	29,439	2,937	32,376

Table II shows the stocks in the hands of manufacturers and dealers in the United States on December 31st of the same three years :—

TABLE II. *

Year.	Manufacturers.	Dealers.	Total.
1922 ...	75,678	18,805	94,483
1923 ...	56,523	20,234	76,757
1924 ...	47,010	10,707	57,717

2. *Coconuts.*

The price of copra was $12.50 per pikul at the beginning of the year and remained fairly steady until the beginning of March when a decline began which reached its lowest point at $10.50 at the end of April. Thereafter the price rose again with minor fluctuations to $13.65 in the latter half of October. In November there was another sharp fall to $11.40 at the end of the month followed by a rise to $13 [illegible] at the close of the year. The average price for the year was $11.95 as compared with $11.30 per pikul in 1923. The price of nuts in the small holdings varied from 3 to 6 cents each. The price of copra has been sufficient to render the industry prosperous, as it was in 1923.

In Table III are given figures kindly supplied by the Commissioner of Trade and Customs showing the export of copra from the Federated Malay States for the last three years.

*These figures were kindly supplied by the Local Secretary of the R. G. A

TABLE III.

State.	Quantity in Pikuls.			Value in dollars.		
	1922	1923	1924	1922	1923	1924
Perak	698,934	588,771	647,710	6,624,165	5,788,380	6,914,055
Selangor	211,266	218,911	216,773	1,982,730	2,239,237	2,427,188
N. Sembilan	5,970	8,257	19,805	54,617	85,401	203,930
Pahang	9,449	8,089	9,421	83,758	77,683	95,839
Totals F M S.	928,619	824,028	893,712	8,745,565	8,190,701	9,641,012
Johore	416,056	455,675	473,610			

There was thus an increase in production of 69,684 pikuls of copra as compared with that in 1923, the increase being general except in Selangor which shows a slight decrease. Only in Negri Sembilan do the figures indicate any considerable increase of the producing area, the improvement in Perak being apparently mainly attributable to improved yields from existing areas, since the exports of copra for 1924 are not as high as for 1922. The export of copra from Johore in 1924 shows an increase of nearly 17,935 pikuls over the 1923 export and is 57,554 pikuls above that of 1922.

A new factory is in course of erection near Butterworth.

It is noticeable that a large number of the palms in Penang and Province Wellesley are very old and bear very small crops. Many die of old age every month. It is, however, pleasing to record that attention has of late been given to the planting of supplies.

The suitability of this crop to the coastal lands of the Peninsula may again be emphasised, especially as the improved prospects for rubber and the possible counter-attraction of Oil Palm may tend to lead to the neglect of a crop that, properly handled, can be relied upon to give steady and reasonable profits.

3. *Padi.*

(i) Season 1923-24.

The padi crop in Province Wellesley for the season 1923-24 was below the average owing to heavy rain and floods during the growing season.

In Perak North the crop was reduced by rain during the harvest which was late because planting was delayed by drought. The crop

on the Perak river was severely damaged by floods, as it was also in other parts of Perak South, in parts of Selangor and of Pahang West.

The padi in Pahang East was almost entirely destroyed by floods.

In some parts of Negri Sembilan, especially Kuala Pilah district, late planting due to scarcity of water and subsequent damage by the insects *Leptocorisa* spp., M. Pianggang, considerably reduced the crop. In other parts of the State average crops were obtained.

In Malacca the crop was satisfactory and increased yields were reported from the Southern district.

It is noticeable that the yields of padi in Johore tend to be abnormally low. In 1924 an area of 5,728 acres was reported to have yielded 538,744 gantangs, or an average of 94 gantangs per acre. This is partly due to damage by floods in that year, but, in general, insufficient control of the water supply and damage by rats are suggested as factors responsible for the poor yields

(ii) Season 1924-25.

On the whole the prospects everywhere for the crop of the 1924-25 season are satisfactory, in spite of the fact that in many places planting was delayed by drought. In Province Wellesley planting was delayed by the drying of the nurseries and by subsequent floods which washed away the newly planted padi, necessitating a second planting. The prospects for the crop are consequently somewhat uncertain, as it may be damaged by rain in the late harvest.

In parts of Selangor also floods washed away the young padi and necessitated two or three plantings, thereby delaying the harvest.

The area planted with padi in Pahang East is reported to be small and the appearance of the plants to be poor.

In Malacca there has been an increase in the total area planted and a good crop is expected, although in parts of the coastal area the drought continued so long that planting was very late and portions of some sawahs could not be planted at all.

(iii) Distribution of Pure Strains.

The distribution of seed of pure strains of padi from Titi Serong Station was continued during the season 1923-24. Satisfactory results from this seed were obtained in Perak generally, in parts of Selangor, in Kuala Pilah district of Negri Sembilan and in parts of Malacca. In Province Wellesley and the Central District of Malacca the yields obtained were no better than those given by local varieties, but the pure strains are expected to show considerably improved yields when they have become acclimatised in the course of two or three seasons. In Johore several plots of these selected padis gave yields higher than the local varieties but lodged badly.

In Kuala Pilah district some of the selected strains, although they gave considerably increased yields, were objected to because

their stalks were thin and in consequence the tuai (reaping knife) hurt the reapers' fingers. It is noticeable that in the 1924-25 season, the stalks of these particular strains have been much thicker. On account of the objection to the thin stalks, several planters said they would not use the selected seed again, but actually in 1924 the same areas were planted again and additional areas also.

The value of the selected strains of padi is becoming far more widely recognised, as is shewn by the large demand for them during the 1924-25 season. Seed has now been distributed all over the Peninsula from Kedah and Kelantan to Johore. The following instances will illustrate the above remarks. In the districts of Larut, Kuala Kangsar and Upper Perak 463 gantangs of seed were distributed for planting in 1924, and in Malacca 1350 gantangs, or sufficient for at least 300 acres. In Negri Sembilan 164 Malays had trial plots of these padis and there were 94 growers in Raub and Kuala Lipis districts of Pahang. Owing to the destruction of the crop in Pahang East, the Department provided for seed in 1924, 1600 gantangs of selected and 8,500 gantangs of unselected Radins.

The above distribution by the Department is in addition to local distribution by Malays themselves from seed supplied in 1922 and 1923. Such distribution has been fairly extensive, even outside Krian District, and areas varying from 15 to 100 acres in extent are known that are each planted with a single pure strain. In Krian the distribution has been far more extensive, especially in the north round Titi Serong Station where it is estimated that between 8,000 and 9,000 acres of the best padi land are planted with selected strains.

(iv) Experiment and Test Stations.

The results obtained at the Pulau Gadong Experiment Station in Malacca for the season 1923-1924 were again disappointing, though better than those of the first year, because the soil had not been fully restored to fertility and still required further cultivation. During the 1924-25 season a further 7 acres were brought under cultivation making the total area planted about 25 acres. Moreover there was a very great improvement in the growth of the padi which promised a satisfactory crop. It can now be considered that the Station is well established and that useful results can be expected in the course of the next few years on lines similar to those obtained at Titi Serong. The work in progress consists of :—

(*a*) Tests of selected pure strains of Radins from Titi Serong.

(*b*) Manurial Experiments.

(*c*) Cultivation Experiments.

(*d*) Ear to row selection of pure lines of certain varieties from Negri Sembilan and Malacca.

The work continued at the Padi Test Stations at Permatang To' Jaya in Province Wellesley and at Talang in Kuala Kangsar District

Power Alcohol.

Investigations in connection with the production of power alcohol have been confined principally to the nipah palm, although work has been started on the tapioca (cassava) plant, chiefly to ascertain the mineral constituents of this plant, and its effect on the soil, owing to its supposed exhaustive character in this respect. The tubers of the tapioca plant must be considered as a potential source of alcohol in tropical countries. The work carried out on the nipah palm has included a continuation of tapping experiments on an area reserved at the 15th mile Klang-Kuala Selangor Road, the planting of nipah palms on a small area reserved at this spot and determinations of the sugar content of the juice and methods of preservation in connection with the possible production of sugar from the juice. A report on the work to date was published in the M. A. J. early in the year. The tapping experiments on indigenous palms have been continued during the year.

A visit was paid to Sandakan by Mr. J H. Dennett towards the close of the year, to inspect the experimental distillery erected for the production of an alcohol-ether fuel from the alcohol obtained from the fermented juice of this palm. This report will be published later.

Sugar.

A small experimental plant for crushing sugar cane grown at the Experimental Plantation Serdang, has been installed on the plantation and investigations have been commenced and are being continued on the sugar content of the various types of cane at different stages of growth and ripeness A large number of samples of juice have been prepared and examined.

A number of samples of Sisal hemp, Pineapple fibre, Roselle fibre, Arghan fibre, Manila hemp and an unknown bast fibre were examined and reported on.

The extraction of fibre from Sisal hemp grown at Serdang was carried out and samples sent to the Imperial Institute for examination and report and samples distributed among various buyers in Australia.

The reports received from the Imperial Institute and from Australian buyers is being prepared for publication in the M A. J. Samples of pineapple fibre and Caraguata fibre were also sent to the Imperial Institute for examination and report and the results received recently will be published in the M. A. J.

The investigations carried out by this Division and the reports received show that Sisal hemp of excellent quality can be prepared from the locally grown product.

Soils and Fertilisers.

One hundred and twenty five samples of soils from estates and other areas have been investigated during the year. These include

soils examined in connection with the cultivation of oil palms, nipah palms, rubber, coconuts, padi (rice) and tobacco. Advice on manuring has also been given to several estates. The results of examination of soils from oil palm estates, indicate that a compact soil with a high degree of capillarity is most suitable for optimum development.

Investigations on the salinity of nipah palm soils do not show any close correlation between suitability for this crop and salt content of the soil. The salinity of the soils from mangrove areas was found however to be higher than that of the banks of the tidal rivers.

A Departmental Committee on Soil investigations has been formed and it has been decided to undertake research on soils in certain specific directions in order to obtain more detailed information in respect of tropical soils.

Investigations on the growth of various leguminous crops in pot culture experiments have been carried out and are being continued, also similar experiments on the fertilising value of Perlis phosphates on ragi.

Analyses of Perlis phosphate have been continued and show that the presence of iron and aluminium does not affect the solubility of the phosphate in citric acid solution. A visit was paid to the Perlis deposits by Mr. Greenstreet. Nineteen samples of bat guano from the Gunong Pondok caves have been examined. Some of these were found to contain 36 per cent of phosphoric acid (P_2O_5) and 21.5 per cent of "citric' soluble" phosphoric acid. The fresh deposits contain as much as 10 per cent of nitrate, calculated as nitric acid. A feature of the richer deposits is that they are soft and require no grinding prior to use.

Miscellaneous Investigations.

A number of miscellaneous investigations were also carried out for various purposes.

Reports were sent to various enquirers in connection with (*a*) the manufacture of tapioca (*b*) bottling and preservation of lime juice (*c*) distillation of woods in Malaya for the manufacture of acetic acid and other byeproducts, (*d*) manufacture of Citrus products.

Applications for Patents.

Forty seven reports on applications for grants of Exclusive Privileges for inventions were made during the year and forwarded to the Government. A report on the procedure and recommendations in this connection was also forwarded to Government.

Publications.

The following articles were published by members of the staff of the Chemical Division during the year.

The Utilisation of Citronella Grass, planted as a Preventive of Soil Wash by C. D. V. Georgi M.A.J., Vol. XVI, No. 1.

twelve companies are at present planting this crop and most of these are in Selangor which is the only State in which there has been any appreciable increase in the planted area. Enquiries for land have been received and one or two new companies are about to commence planting operations. Suitable factory plant now appears to be available for areas of varying size from 200 acres upward. There is good reason for the opinion that this crop is well suited to this Peninsula and can be expected to give a reasonable and regular profit.

Betel Nut.—The principal region from which this crop is produced for export is the west coast of Johore. In spite of high prices throughout the year the export from Johore decreased by about 50,000 pikuls. This decrease is mainly accounted for by the fact that large numbers of trees are becoming too old to bear fruit, while the new areas of the crop are not extensive enough to replace them. Though old age accounts for the fact that a number of trees are becoming unproductive, there are indications that disease may be a contributing factor. It seems probable that the decrease in export will continue for several years, as the newly planted areas appear to be far from equal to those becoming unproductive, and this decrease may serve to keep up the price of the produce.

Tapioca.—The price of this crop has been good and there has been an extension of the area planted both in Johore and in parts of Negri Sembilan. Its cultivation is usually combined with pig rearing, as the industry is mainly in the hands of the Chinese. In Johore rubber is usually planted as a permanent crop with tapioca.

Other crops that have attracted some attention on account of improvement in their price are coffee and gambir, while tuba (Derris spp.) is grown on certain Japanese estates in Johore and on a small scale in a few other localities in the Federated Malay States.

IV.—Diseases and Pests.

1. *Rubber.*

Pink Disease (*Corticium salmonicolor*).—This disease was newly reported from 20 estates in the Federated Malay States, the Colony and Johore.

As usual the prevalence of the disease depended largely on the rainfall; wet weather towards the end of the year caused a rapid increase in the number of cases in some districts. There was a definite spread of the disease in Selangor from the boundaries of Ulu Selangor, Kuala Selangor and Kuala Lumpur districts near Kuang in a South-westerly direction to the Kuala Lumpur—Klang Road near Seaport Station. Throughout this area cases were comparatively numerous on estates and holdings formerly free from the disease.

Mouldy Rot. (*Sphaeronema fimbriatum*):—This disease was newly reported from 16 Estates during the year.

In Perak North this disease appeared for the first time at Selama and Ulu Selama in September and at Batu Kurau in November. In Pahang new outbreaks were found at Tras in July and in December at Simpalit near Raub and at Panggong near Kuala Lipis. In Malacca 21 additional mukims became infected; in most the disease was confined to a few holdings only. In Johore during the first half of the year new outbreaks were found at Senggarang in Batu Pahat District, near Sungei Senglang in Kukub District, and at Tanah Merah in Muar district. In September one estate and an adjoining holding were found to be infected in Singapore Island. In most cases the spread of the disease was associated with the movement of tappers from previously infected holdings.

Every effort has been made to teach rubber growers how to recognise and treat this disease and to demonstrate the effectiveness of the treatment in preventing serious damage to the trees. The methods of instruction used have comprised lectures and demonstrations in the field, the distribution of a pamphlet in four languages, and the exhibition in Kuala Lumpur of a cinematograph film.

These measures combined with a certain amount of compulsion, where necessary, have resulted in the regular treatment of diseased trees in all the infected areas, so that the disease now causes but little serious damage. The fact that under restricted production many holdings are only tapped for 6 weeks or two months in each quarter has also assisted in the control of the disease.

Black Stripe. (*Phytophthora sp.*). This disease was not much in evidence. It was newly reported from 3 Estates in Negri Sembilan.

Root Diseases. (*Fomes lignosus, F. pseudoferreus, Ustulina zonata, Sphaerostilbe repens* and Brown Root Disease):—These call for little comment, though they are still somewhat prevalent in Johore.

General Sanitation.—A total of 568 notices were served requiring the removal of dead rubber stumps or trunks. Nine persons were prosecuted for failure to obey instructions; all were convicted and fined. For severe wounding owing to bad and excessive tapping 54 notices were served. These gave rise to 4 prosecutions.

2 *Coconuts.*

Beetles. Black Beetle (*Oryctes rhinoceros*) and Red Stripe Weevil. (*Rhyncophorus schach*):—The routine work of controlling these insects was steadily maintained throughout the year. On the whole it has been successful, though numerous breeding grounds still remain to be destroyed in Penang, Province Wellesley and parts of Singapore island. Persistent inspection is still necessary in Klang and Kuala Selangor districts of Selangor.

Artona (Brachartona) catoxantha.—There were small outbreaks of this caterpillar at Lenggong in Upper Perak and in Krian at the

7th mile on the Tanjong Piandang road, also at Sungei Ayer Tawar in Kuala Selangor District. These all occurred in the first half of the year and were controlled by the natural enemies of this insect. In the second half of the year an Entomologist, Mr. Lee, and the Plant Inspector, Mr. Macnamara, from Fiji visited Malaya in search of insect parasites of *Artona catoxantha* likely to be of service in controlling an allied insect, *Levuana iridescens*, on coconuts in Fiji. Unfortunately at the time of their visit no outbreaks of Artona could be found, and a careful search of previously infected localities failed to discover any of the insects.

Skipper caterpillars (*Hidari irava*) did some damage in Kinta District, at a few places in Kuala Pilah district and in Temerloh district in the first half of the year. Small outbreaks of *Plesispa reichii* were recorded at Kota Tinggi in Johore.

Squirrels annually cause serious losses, by destroying a number of nuts, in several parts of the country, notably in Pahang and to a less extent in Malacca. Efforts are being made to encourage the systematic use of traps and regular hunting to reduce the numbers of these animals. Other animals that do damage to coconuts in the neighbourhood of jungle are monkeys, pigs and bears.

Disease.—The cause or causes of the death of coconut palms on the West coast of Johore referred to in the report for 1923 (M. A. J. Vol. XII p. 224) have not yet been definitely determined, although the matter has received considerable attention. Steps have been taken to ensure the removal of all dead or dying palms and efforts will be made to improve general sanitation on these coconut holdings. A pamphlet in Malay on this subject has been issued.

3. *Padi*.

Leptocorisa spp, M. Chenangau or Pianggang.—These insects did damage to padi at Ulu Selama in Perak during the first quarter of the year. At the end of the year they were reported as a minor pest in Johore. In Kuala Pilah district of Negri Sembilan, however, they became extremely prevalent in many localities during the last quarter of the year and threatened to do very serious damage as they did at Inas and Johol in 1923 (M. A. J. Vol. XII p. 227). Fortunately it was possible to develope a method of catching the adults in large numbers before the eggs were laid. This consisted of dipping old fish nets in a sticky mixture of Kruing Oil and Jelutong, or some other latex such as Getah Trap. "Racquets" made of fine pieces of palm leaf midrib, or bamboo, tied to a long handle, and arranged like the ribs of a fan, were also dipped in the mixture. By waving the nets and 'racquets' over the padi, the insects were disturbed and caught in large numbers. The District Officer induced all owners of padi land in the infected areas to catch the insects by these means. With the vigorous assistance of the Agricultural Field Officer Negri Sembilan, and the Malay Officers of both the Land Office and the Agricultural Department the workers were well organised and the pest was most effectively controlled. Work was still in progress at

the end of the year, but results already obtained were very satisfactory, as it could be seen that the crops had been saved from damage of any importance in all those places where the work had been completed.

Stem borers.—The different species were present throughout the Peninsula from Province Wellesley to Johore at the end of the year, but were on the whole not numerous and did little damage, except at the Experiment Station in Malacca where they caused loss of an appreciable portion of the crop.

Army Worm, Spodoptera mauritia.—This pest destroyed an area of 100 acres of newly planted padi in the mukim of Kota Lama Kanan in Kuala Kangsar District, Perak. The area was replanted and practically no damage was done to the replanted padi.

Nymphula depunctalis.—This insect attacked the padi at the Malacca Experiment Station about a fortnight after it was planted out. It threatened to do considerable damage, especially as the plants were also suffering from the effect of soil acidity, but was controlled by hand picking.

Scotinophora coarctata, M. Bena kura or Kutu bruang.—This pest did a certain amount of damage in the sub-district of Bruas and in Senggang mukim of Kuala Kangsar District. It also occurred at places along the Perak River in Lower Perak District and in Pekan District of Pahang; it was recorded among minor pests in Johore.

The occurence of *Nephotettix bipunctatus* was recorded as a minor pest in Johore. Mole crickets, M. Sesorok, did a little damage in Lower Perak District.

Rats. —These animals damaged padi everywhere, as they do every season. Distribution of barium carbonate at cost price was continued. though in places the supply was insufficient for the demand. Reports on the efficiency of the poison have again varied. On the whole, however, its use is increasing considerably. There is a greater interest among padi growers in the application of methods of destroying rats, including trapping as well as poisoning, and occasionally hunting. Padi growers, however, still fail to realise the necessity for sustained and concerted work.

In order to increase the interest of padi growers in the control of rats and to afford an opportunity for experiments with new methods of control, various forms of bait and the like, a special campaign* against rats was commenced in a definite part of Krian District of Perak on November 15th.

Cotton.—A cotton leaf roller, *Sylepta derogata*, attacked trial plots of a strain of Egyptian cotton in Province Wellesley. The plots were small and the pest was controlled by hand picking. If cotton were planted on a large scale the control of this pest might be a factor of importance.

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*For details see this Journal XIII, No. 6, p. 168.

Achatina fulica.—These giant snails were spreading steadily around Butterworth in Province Wellesly during the first half of the year. However, floods in August killed off many of them, while many others forsook the undergrowth and climbed fences or anything else above water, so that they were easily collected and destroyed. Since the floods very few of these snails have been seen.

5. *Other Pests.*

Water Hyacinth.—In the Federated Malay States the destruction of the weed received regular attention, when necessary, and the work calls for little comment. In Negri Sembilan 13 notices were served for its destruction. Three persons were prosecuted for failing to obey instructions; two were convicted and fined a total sum of $30/-.

In Province Wellesley the weed is becoming very prevalent in drains and waterways and is interfering with the drainage of padi fields. It is also spreading considerably in Malacca. In consequence of this legislation has been suggested to enforce its destruction in the Colony on the same lines as in the Federated Malay States.

Mistletoe.—The destruction of various species of mistletoe on different host plants has received attention everywhere, especially in Pahang where these pests are common.

Lalang and Blukar.—Much attention has been paid to enforcing the removal of excessive growths of lalang, blukar and other undergrowth on small holdings during the year, particularly where their presence provided conditions favouring the development and spread of Mouldy Rot of rubber or other diseases. This work continued to meet with a certain measure of success, but it requires continual attention.

TABLE IV.

Summary of Notices Served and Results.

Cause.	Notices Served.	Prosecutions.	Convictions.
Rubber :—			
Pink Disease	1,191	52	50
Mouldy Rot	3,381	327	272
Black Stripe	54	Nil	Nil
Rubber Timber	568	9	9
Bad Tapping	54	4	4
Coconuts :—			
Beetles	2,722	173	154
Water Hyacinth	13	3	2
Mistletoe	84	3	3
Lalang and Bush	8,386	753	689
Totals ...	16,453	1,324	1,183

V. Instruction.

1. On November 15th a re-organisation of the work of the Department came into force whereby the Inspection Division took over all forms of field work, other than that on Experimental Plantations, including all branches of field instruction and work in School Gardens. At the same time the title of the Division was changed to that of "Field Division" (M.A.J. Vol. XII, No. 12 p. 380.)

2. On July 11th, 12th and 13th The Malayan Agri-Horticultural Association held a very successful Show and Trades Exhibition in Kuala Lumpur. Mr. G. E. Mann, Assistant Agricultural Inspector, Selangor, was Organising Secretary. The Inspection Division provided an exhibit of rubber diseases and also assisted in the Agricultural section of which a noticeable feature was the padi exhibit, both for the number of entries, which totalled over 2000, and for their quality. A successful Show was held at Seremban on August 9th at which the Chief Agricultural Inspector judged and the Assistant Agricultural Inspector, Negri Sembilan was joint Secretary. Officers of the Division also assisted at 3 District Shows in Pahang and 3 in Negri Sembilan. At all the District Shows there was a distinct improvement in the quality of the exhibits and also in the organisation.

3. In March the Economic Botanist again gave a demonstration to numerous penghulus and other Malays interested in the work at the Padi Experiment Station at Titi Serong. Officers of this Division attended both to assist and to improve their knowledge of the selected strains of padi.

4. A Conference of Malay Officers of the Department was held on November 18th, 19th and 20th. Papers were read in English and Malay and were discussed by the Officers with considerable interest. The last day was allotted to a visit to the Experimental Plantation, Serdang.

5. This Division has taken over the work in School Gardens too recently to enable a report to be submitted this year.

6. At the close of the third quarter an Advisory Committee for Chinese Agriculture was established with a view particularly to assisting and encouraging Chinese market gardeners and producers of fruit and poultry for local consumption. The Chief Agricultural Inspector was appointed Secretary to this Committee. The Committee held meetings on September 13th, October 17th and November 21st. A Chinese Sub-Inspector of Agriculture was appointed and a considerable amount of preliminary work was done.

VI. General.

In June the Chief Agricultural Inspector visited Palembang Residency, Sumatra, to enquire into the conditions of cotton cultivation there, since this cotton is all sent to Singapore for transhipment This visit was connected with the revision of the Plant Importation Rules, proposals for which have been completed.

ANNUAL REPORT OF THE ECONOMIC BOTANIST FOR 1924.

By H. W. Jack.

I.—Staff.

H. W. Jack, Economic Botanist; W. N. Sands, Assistant Economic Botanist, who went on furlough in April until the end of the year; Inche Ahmad bin Johar, Junior Agricultural Assistant, a promising officer who unfortunately died on 31.1.1924; 'Che Din, Junior Agricultural Assistant; Inche Mohamed Zain, Probationary Assistant, who acted for Inche Ahmad bin Johar; and Inche Abdul Rauf, Field Assistant.

I desire to express my appreciation of the good work done by the entire staff throughout the year.

II.—Padi.

Experimental work at Titi Serong Experiment Station was continued throughout the year, 'Che Din being in charge. The first two months were taken up with recording vegetative characters of the different varieties of padi grown as foundation stocks before harvest which commenced at the end of March in rainy weather.

The standing crops were heavy but the rains during harvest spoilt much grain, rendering harvesting operations arduous and reducing excellent crops to average ones.

During harvest, the opportunity was taken of demonstrating the returns obtained by growers of selected seed.

In one place in particular where some 40 acres of strain No. 36 had been grown in one block (the result of re-distribution from an original two gantangs of seed), sections of the crop were cut, threshed, measured and weighed, all operations being done in the presence of a a number of cultivators, and it was found that the average yield of the block was 910 gantangs of padi per acre—easily the heaviest in the mukim. When the entire crop from this block was harvested, 40 bags were weighed and the average weight per bag was found to be 109 katis, which is approximately 10% heavier than the weight of an equal quantity of unselected padi.

Just prior to harvest, some 250 visitors from various parts of the country and many local cultivators visited Titi Serong and appeared

to be favourably impressed with the heavy and uniform crops then standing in the fields. The Experiment Station was honoured by a visit of H. H. The Sultan of Selangor and Dato Lee Kong Lam. His Highness seemed to enjoy his visit and showed his interest and knowledge of the rice crop by asking many pertinent questions.

Thirty-four strains were tested for yield in season 1923-24, and from them, fourteen strains were selected for continuation tests in the present season. Of these fourteen strains, five (Nos. 36, 15, 48, 52 and 68) are particularly suitable where soils are soft heavy clays under irrigation, while three (Nos. 2, 7 and 13) are more suited to the harder drier soils, being of shorter maturation period.

In Krian, strains No. 36, 52 and 15 for the deeper soils and No. 2 for the drier soils, were in large demand for seed for the present season ; and 4,700 gantangs of seed were distributed to applicants for sowing in the present season (40% of this amount being No. 36.)

In addition to this distribution from Titi Serong Experiment Station, a considerable amount of natural redistribution has taken place from centres where selected seed was grown in Season 1923-24, so that in the present season it is safe to say that at least 8,000 acres in Krian have been planted with selected seed.

Some 5,600 gantangs of selected seed were distributed to districts outside Krian, to applicants and to Field Officers and others for trial purposes, further trials being made in all the Federated States and in Penang, Malacca, Kedah, Kelantan and Trengganu.

The present season started badly in Krian as a heavy flood in August swept away many seed nurseries. Eelworms and borers were apparent in several areas and rats were unusually destructive to the young planted padi. At flowering, quite a considerable amount of "smut" was apparent but the standing crops promise a good crop. Padi prices, however, are likely to be high on account of the competition which has arisen owing to the increased number of mills in the neighbourhood of Krian, though the bumper crops available for export from Burma may keep local prices of padi down somewhat.

In Malacca, in co-operation with the local Agricultural Field Officer, pure line selection work with types of padi long grown in Malacca was started.

Manurial schemes were drawn up and inaugurated in Malacca and Province Wellesley and maintained in Kuala Kangsar during the present season.

Dry padi cultivation is being tried at Serdang where four good varieties were planted during the present season, with a view to selection of heavy yielding strains.

In Kedah, two strains (Nos. 52 and 7) have already gained favour and this year over 1,000 gantangs of seed of these strains were distributed. Strain No. 13 is already established in one mukim where it was tested successfully in 1920. Strains Nos. 36 and 2 are being tried for the first time this season.

In Trengganu, strain No. P. 1., tried in Season 1922-23 became popular, and a fair area was planted with it this season.

Seven strains are being tested in Kelantan this season—thanks to the assistance of the British Adviser.

In Perak, at Talang Test Station, strain No. 13 maintained its good promise of the previous season and is now widely planted in neighbouring bendangs. Strain No. 1 has spread considerably in several mukims of Kuala Kangsar, while in Lower Perak selected strains (Nos 36, 7 and 2) were in large demand and now cover quite a fair area.

In the Kuala Pilah District of Negri Sembilan, strain No. 7 yielded heavily in Season 1923-24 and has been planted on a considerable area this season in several mukims.

In Selangor, good crops from selected seed are reported at Klang (strains Nos. P. 1 and 52), and in Kluang strain No. 2 is said to be the best crop in the mukim.

In Pahang, a large quantity of seed was distributed in the Pekan (strains Nos. 7 and 2) and Kuantan (strains Nos. 7 and 13) districts, and though much damage was done by floods, quite good crops were taken in several areas. In Raub several trial lots showed good promise.

In Penang, heavy crops are reported from strain No. 36. In Province Wellesley strain No. 7 is promising well and is gradually spreading from the Test Station there; and strain No. 15 has given good crops.

In Malacca, strains Nos. P. 1., 7 and 11 are gaining local favour, though better results are anticipated from strains of local origin which are now being isolated for selection.

In Johore, strain No. 756 was said to have given excellent crops in the Muar District

In the present season numerous test plots have been planted with selected padi in many parts of the country and growth is good though results are not yet available.

Some 200 strains of various varieties of padi were maintained as foundation stocks at Titi Serong Experiment Station.

The usual statistics regarding the area under rice and the yields obtained in each district were collected from District Officers and others and are compiled in the following table: —

SUMMARY OF PADI RETURNS—BRITISH MALAYA.

State or Settlement.	1923. Area in acres.	1923. Yield in gantangs.	1923. Average yield per acre.	1924. Area in acres.	1924. Yield in gantangs.	1924. Average yield per acre.
Federated Malay States.						
Perak -	106,734	21,276,516	227	102,835	23,654,413	230
Selangor -	11,635	1,737,172	149	18,076	4,017,483	222
N. Sembilan -	30,756	5,196,171	169	30,581	5,608,978	183
Pahang -	28,472	4,581,861	161	26,260	3,889,489	148
Total, F.M.S	177,597	35,791,730	202	177,742	37,165,363	209
Krian -	54,605	14,484,806	265	54,054	14,126,049	261
Straits Settlements.						
Singapore -	...	...	...	...	...	...
Penang -	5,150	2,033,010	395	5,109	2,020,560	395
Malacca -	26,560	7,950,060	300	26,669	9,915,954	3[illegible]8
P. Wellesley -	41,700	11,350,000	321	40,166	13,400,000	334
Dindings -	695	77,475	111	355	35,500	100
Total, S.S -	77,045	24,410,515	317	72,299	25,402,014	351
Unfederated Malay States.						
Johore -	16,990	840,001	49	8,362	660,125	78
Kedah -	117,009	48,452,102	330	154,568	40,808,870	264
Perlis -	29,125	7,361,920	253	37,738	8,075,600	240
Kelantan -	169,995	33,799,800	199	170,910	34,039,700	199
Trengganu -	11,000	1,700,000	155	12,000	1,700,000	142
Total, U M.S.	374,119	92,153,323	246	401,166	85,284,295	213
Summary—F.M.S., S.S., and U.M.S.						
Total, F.M S.	177,597	35,791,730	202	177,742	37,165,363	209
Total, S.S. -	77,045	24,410,515	317	72,299	25,402,014	351
Total, U.M.S.	374,119	92,153,323	246	401,166	85,284,295	213
Grand Total Malaya -	628,761	152,355,568	242	652,207	147,851,572	227

III.—Coconuts.

In connection with the study of variation and selection experiments, individual palm yields of fruit were recorded monthly from 450 palms.

These records, while primarily maintained for the above purposes, will be of considerable utility as supplying data for examining the periodicity of yields and the existence of correlations between rainfall and fruiting and between type of tree and yielding ability.

A study is also being made of the various local and several introduced types with a view to comparison of varieties and classification.

Selection experiments were started on a fifty-acre block of heavy alluvial land near Klang, which was cleared of lalang, drained, holed and planted with seedlings from selected trees. Twenty-five seedlings from each selected parent palm were planted. Except where the germination of the seed nuts was slow or bad the number of seedlings available proved insufficient. To-date about 40 acres have been fully planted, whilst nurseries supplied with seed nuts sufficient for the completion of planting are established.

The plantings include seedlings from 84 palms selected as heavy yielders in the varying conditions of Province Wellesley, Bagan Datoh and Selangor Coast—three of the chief commercial coconut growing areas in Malaya. In addition plantings have been made of 35 lots of seedlings representing 24 different local varieties, 5 Ceylon and 6 Philippine varieties.

A few of the catch crops commonly found in coconut plantations have been planted to test their effects on the coconuts. They include sweet potatoes, tapiocca, ground nuts, coffee, soya bean, chillies and gingelly. Also some of the manures of possible commercial utility, such as lime, superphosphate, guano, salt and fish offal, have been applied to certain groups of palms to demonstrate their efficiency.

Articles dealing with the "Dwarf" Coconut and on "Variation in Coconuts" were submitted for publication during the year.

Efforts were made to verify the statistics of the areas under coconuts given in the Annual Report for 1923. The following figures cannot be regarded as accurate as the areas are, in many cases, calculated from the number of palms, assuming 50 palms per acre as a fair stand, or from copra exports; still, they show the comparative areas in the various States or Settlements and are probably not far wrong.

F.M.S.	acres.	S.S.	acres.	U.M.S.	acres.
Perak -	75,281	Singapore -	6,565	Johore -	92,500
Selangor -	62,117	Malacca -	45,000	Kedah -	27,550
N. Sembilan -	6,604	Dindings -	6,000	Kelantan -	70,900
Pahang -	19,400	Province Wellesley	55,000	Trengganu	8,000
		Penang -	15,000	Perlis -	2,578
Total -	163,402	Total -	127,565	Total -	201,528

	acres.
Total F.M.S. -	163,402
Total S.S. -	127,565
Total U.M.S. -	201,528
Grand Total Malaya -	492,495

Of this large area planted with coconuts, 412,272 acres or 83.7% of the entire area consists of holdings less than 100 acres in extent which are almost entirely owned by Asiatic cultivators, showing strikingly the large interest they have in the local copra industry and the production of coconuts for local consumption.

The following table is compiled from figures collected by the Field Officers of the Department:—

Areas of Estates of over 100 acres in extent.		
F.M.S.	S.S.	U.M.S.
61,996 acres.	16,969 acres.	9,013 acres.
Total = 87,978 acres.		

The average yield of copra per acre from 15 representative estates scattered over the Peninsula was 8.22 pikuls in 1923 as against 9.22 pikuls in 1922, showing that, seasonally, 1923 was a poorer year than 1922. Probably 1924 will show a similar average production figure to 1923 as rains have been very frequent throughout the year.

IV.—Cotton.

With the upward tendency in the price of rubber interest in this crop diminished, though trials are being conducted in numerous districts, a few of which show good promise.

The following results were obtained in 1924 under pure line cultivation conditions in poor sandy soil in Kuala Lumpur.

Strain No.	Origin.	Average Wt. of seed cotton per plant in grams.	Calculated Wt. seed cotton per acre in lbs.	Calculated Wt. of lint per acre reckoning 30% lint
				lbs.
1—1	Egyptian	29	390	115
1—2	,,	42	545	160
2—1	,,	37	485	145
3—1	,,	28	365	110
3—2	,,	39	500	150
3—3	,,	46	590	175
4—1	Sea Island	24	310	90
4—2	,,	25	320	95
5—1	,,	14	180	55
5—2	,,	20	255	75
6—1	,,	23	300	90
6—2	,,	39	510	150
7—1	,,	30	390	115
7—2	,,	24	300	90
8—2	,,	9	120	35
16—1	Egyptian	20	255	75
16—2	,,	8	110	35
17	Sea Island	6	70	20
21	Cambodia	13	160	50

The above results are based on plots of 50 plants planted 2 × 3½ feet on ridges, but the soil was so poor that nearly double the number of plants could have been sown in the same sized plots with beneficial

results. The seed was sown at the end of February and good showery weather was encountered throughout the growing period. The months of July and August afforded ideal harvest conditions. Each strain was the progeny of a single plant selected from previous sowings in 1923. All the seed was gathered from self-pollinated flowers

The above yields of lint though worked out from rather small plots (and hence possibly misleading) compare quite favourably with yields in the British West Indies, India and America. Better yields have been obtained in better soils where trials have been conducted by planters but no reliable records of actual yields are yet available. In two places, 100 bolls per plant have been reported in small patches.

The weight of seed cotton per plant showed enormous variation on account of the patchy nature of the soil on which the trial was conducted. Some plants yielded over 170 grammes of seed cotton per plant, though the averages as shown are low in most cases.

Pests (Leaf Roller, Cotton-Stainer, Boll-worm, Green Fly) were noticeable in all stages of growth, but were readily controlled.

Samples of lint were sent to the British Cotton Growing Association, Manchester, for report and valuation and some samples were commented on very favourably and highly valued—notably strains Nos. 3-3, 2-1, and 4-2 which were valued at 26d., 26½d., and 27d., per lb, respectively in August 1924.

The best prospects for cotton cultivation appear to be in the Eastern States of the Peninsula where suitable land is available, where more regular and dependable seasons are the rule and where rubber does not dominate the agriculturist.

V.—Rubber.

Little has been done with this crop except to maintain records of individual tree yields of latex. These records have now been maintained for over four years and a summary of four years' figures may be of interest

A.—Paradise Estate, Kajang.

On the above estate, where the trees were planted in 1896 in rows 10x15 feet apart and were severely tapped up to 10 feet up the trunk during the boom period, extraordinarily high yields were maintained by several trees. The tapping system for the last 10 years has been a V over half the circumference, tapped alternate daily.

The following table shows the groups and frequencies for 394 trees. The yields are given in cubic centimetres of latex and are the averages per tree per tapping over four years. There were 9 test

collections per year, at intervals of 5-6 weeks. The figures show that 47% of the crop is derived from 27% of the trees.

Group.	Frequency.	F. x G.	d.	d².	Fd².
5	10	50	60	3,600	36,000
15	27	405	50	2,500	67,500
25	41	1,025	40	1,600	65,600
35	44	1,540	30	900	39,600
45	55	2,475	20	400	22,000
55	46	2,530	10	100	4,600
65	31	2,015	0	0	0
75	33	2,475	10	100	3,300
85	25	2,125	20	400	10,000
95	17	1,615	30	900	15,300
105	17	1,680	40	1,600	25,600
115	7	805	50	2,500	17,500
125	6	750	60	8,600	21,600
135	7	945	70	4,900	34,300
145	6	870	80	6,400	38,400
155	4	620	90	8,100	32,400
165	3	495	100	10,000	30,000
175	5	875	110	12,100	60,500
185	3	555	120	14,400	43,200
195	3	585	130	16,900	50,600
205	0	0	140	19,600	0
215	2	430	150	22,500	45,000
225	2	450	160	25,600	51,200
235	1	235	170	28,900	28,900
	N = 394	FG=25,500			Fd = 743,200

$$\text{Mean} = \frac{\Sigma \text{ F. G.}}{\text{N}} = \frac{25,550}{394} = 64.8, \text{ say } 65.$$

$$\text{Standard Deviation} = \sqrt{\frac{\Sigma \text{ Fd}^2}{\text{N}}} = \frac{743,200}{394}$$

$$= \sqrt{1,886}$$

$$= 43.4$$

$$\text{Coefficient of Variability} = \frac{\text{S.D. x } 100}{\text{M}} = \frac{43.4 \text{ x } 100}{65}$$

$$= 67.$$

B.—Seaport Estate, Selangor.

On the above plantation where the trees were thirteen years younger than Paradise Estate, and where the planting distances were 12 feet, by 24 feet, similar data were collected.

The following table shows the groups and frequencies for 209 trees, planted in 1909, and the average yield of latex per tapping per tree in cubic centimetres over a period of four years. Collections were made once every five weeks approximately. These figures show that 55 per cent of the crop was derived from 28 per cent of the trees.

Group.	Frequency.	F. × G.	d.	d^2.	Fd^2.
5	8	40	60	3,600	28,800
15	20	300	50	2,500	50,000
25	17	425	40	1,600	27,200
35	35	1,225	30	900	31,500
45	22	990	20	400	8,800
55	19	1,045	10	100	1,900
65	18	1,170	0	0	0
75	11	825	10	100	1,100
85	10	850	20	400	4,000
95	4	380	30	900	3,600
105	14	1,470	40	1,600	22,400
115	3	345	50	2,500	7,500
125	3	375	60	3,600	10,800
135	5	675	70	4,900	24,500
145	5	725	80	6,400	32,000
155	2	310	90	8,100	16,200
165	3	495	100	10,000	30,000
175	5	875	110	12,100	60,500
185	2	370	120	14,400	28,800
195	1	195	130	16,900	16,900
205	1	205	140	19,600	19,600
215	1	215	150	22,500	22,500
	N = 209	FG = 13,505			Fd^2 448,600

$$\text{Mean} = \frac{\Sigma\ \text{F.G.}}{\text{N}} = \frac{13{,}505}{209} = 64.6, \text{ say } 65.$$

$$\text{Standard Deviation} = \sqrt{\frac{\Sigma\ \text{Fd}^2}{\text{N}}} = \sqrt{\frac{448{,}600}{209}}$$

$$= \sqrt{2{,}146}$$

$$= 46.3$$

$$\text{Coefficient of Variability} = \frac{\text{S.D.} \times 100}{\text{M}} = \frac{46.3 \times 100}{65}$$

$$= 71.2$$

It is of interest to note that the two areas show a fairly comparable coefficient of variability, though they were of such different

ages and the trees grew under markedly different soil conditions and planting distances.

Moreover, both sets of figures show that approximately half the crop is derived from 25 percent of the trees.

VI.— CINCHONA.

Small cinchona nurseries were established on Cameron's Highlands in July and the seedlings, which are doing well, were transplanted to secondary nurseries at the end of the year. Some 2,500 seedlings representing the two varieties, *C. Ledgeriana* and *C. Succirubra*, are thriving and additional primary nurseries are being sown with a view to planting up 3 acres.

Tea and coffee nurseries are also being established on Cameron's Highlands where soya bean, sweet potato and ground nuts produced good crops from small plots sown in July.

VII.—BOTANICAL.

Numerous identifications of plant material were carried out for other officers of the Department, for planters and the police (drugs).

A considerable amount of material, sketches etc., was obtained of various types of "tuba" and "patchouli" for investigation in the near future.

ANNUAL REPORT OF THE MYCOLOGIST FOR 1924.

By A Sharples.

Staff.

THE Mycologist returned from long leave on 12-3-24 and took over from the Acting Mycologist, Mr. A. Thompson ; Mr. F. R. Mason 2nd Assistant Mycologist was transferred to the Inspection Division at his own request, and assumed duties as Assistant Field Officer, Province Wellesley and Penang on 13-6-1924.

Rubber.

General.—In view of the scheme for the formation of a Rubber Research Institute, no work on Rubber other than that in hand has been undertaken. The work in hand will take a considerable amount of time to round off, but any new features have been carefully noted to be utilised according to future developments in Rubber Research.

Since my return from leave two noteworthy features are of interest During the year " change-over" tapping i. e. "Daily Tapping for periods varying from 2 to 4 months, with 2 to 4 months rest following" has been much in vogue. There is no doubt that " Daily Tapping" over a 3 or 4 months period has resulted in a number of calls for advice regarding disease symptoms on the tapping cut, which cannot be placed under any of the better known Bark Diseases. Fortunately Malayan planters are aware of the danger attached to neglect of obscure disease symptoms and in all cases these outbreaks were taken in time and successfully dealt with. Isolation and inoculation experiments were carried out to determine the causal organism if possible, but no success was obtained. After this years experience I would definitely state that, in Malaya, Daily Tapping over a period greater than three months holds elements of danger in view of the decided tendency for fungi usually saprophytic, to veer towards a parasitic habit and that from the point of view of disease prevention Alternate Daily Tapping must be considered definitely superior to Daily Tapping.

The other question of importance is that of *Root Diseases on Old Rubber*, and the question of treatment. On many old areas in Malaya a 10-15 per cent of trees can be found suffering from various root diseases, usually Wet-Rot caused by *Fomes Pseudo ferreus*, some form of Brown Root disease, or Dry-Rot caused by *Ustulina zonata.* If the percentage number of diseased trees rises above a limit such that treatment by removal will cause the yield per acre to fall below an economic level, it would be an unprofitable course to suggest treatment along such lines. Every case of this description needs individual consideration for many factors are involved. What is the lowest economic yield per acre ? What is the benefit derived by the healthy trees after complete removal of the diseased trees etc ? With

reference to the latter question there is some experimental evidence to show that in certain areas reduced to 40 trees per acre, the healthy trees have benefitted to such an extent, as shown by increased yields, that expensive treatment has been amply repaid. But in one case, where results were satisfactory, and a neighbouring estate tried the same policy, no immediate benefits were derived. This again shows the dangers of generalisations in experimental work, where apparently small differences in soil condit ons are liable to influence results to an enormous degree.

Root Disease

Dealing with specific root diseases, there is little of interest to record. Considerable systematic work has been undertaken recently by Dr. C. van Overeem in Java and as a result it is suggested that Rubber planters lose a friendly old name in *Fomes lignosus* (Kl.) which now becomes *Rigidoporus microporus* (Swart) van Overeem nov. comb. This observer has shown that this common fungus has been given 34 different names by different systematic mycologists, but it is doubtful, if from the applied point of view we can part company with *Fomes lignosus* (Kl.). While the difficulty of stating the accurate systematic position of a disease-causing fungus is of considerable scientific importance for research workers, there is really no reason why planters should not retain a name which has grown into common use since the earliest planting days.

Ustulina zonata and *Fomes Psuedo-ferreus.*

Dr. C. van Overeem has also dealt with these two fungi and has brought forward good evidence for showing that *Ustulina zonata* (Lev) Sacc should be known as *Ustulina Maxima* (Web) Von Wettstein. With reference to *Fomes Psuedo ferreus* and Wet Root Rot of Rubber, Drs van Overeem and Steinmann have studied a similar disease in Java and conclude that the causal organism is *Ganoderma ferreum* (Berkeley). The writer has been in communication with Dr. van Overeem and has exchanged specimens but cannot agree, at present, that they have brought forward sufficient evidence to consider *Ganoderma ferreum* as the cause of "Wet-Root" Rot in Malaya.

Bark Diseases.

Mouldy Rot.—The situation is practically unchanged from last year. Mouldy Rot has been reported from fresh centres and it seems quite probable that the early fears of continuous spread, as expressed by us in 1920, are likely to be realised. Owing to the bulletin dealing with this disease being out of print, and the continued interest shown because of its appearance in fresh centres, a new bulletin on Mouldy Rot is in course of preparation.

Black Stripe.

Nothing new to record.

Brown Bast.

A bulletin on this subject was issued during the year detailing 4 years tapping experiments. Various interesting observations were made. The evidence favoured the interpretation of a "physiological" disease with excessive extraction of latex as the predominating influence During the restriction period, there has been practically no demand for advice in respect of this trouble.

Probable New Bark Disease.

This was reported by the Acting Mycologist in the last Annual Report. A short article was written up in the Malayan Agricultural Journal; since this report inoculation experiments have definitely proved the fungus to be weakly parasitic.

Palm Diseases.

The greater part of my time during the year has been spent in studying Palm Diseases. Planting interest in African Oil Palms led to the inception of these studies for little definite information regarding Palm diseases was available up to two or three years ago. The most important study in Palm Diseases was that of "Bud-Rot" a classical instance of an Epidemic Plant Disease

Bud-Rot.

McRae working in India, has recently published a comprehensive treatise relating to this disease. This work has cleared the position with regard to "Bud-Rot" in the Middle East to a considerable degree. Working chiefly on the Palmyra Palm (*Borassus flabellifera*), he has proved conclusively that *P. palmivora* (Bull.) is the causal agent of "Bud-Rot" in this palm and also on Coconut Palm. For Malaya the following quotation is of special value "On Palmyra Palms in India "Bud-Rot" is a serious epidemic disease which spreads slowly but can be controlled by systematic measures. Coconut Palms, in districts where the causal fungus is present, *are relatively free from attacks by the fungus.*" This moderate statement by Mc.Rae, based on close association with this problem for several years, differs widely from the usual alarmist statements made when this problem is under consideration.

"Bud-Rot" on mature African Oil Palms had caused a fair amount of trouble on a Malayan Estate and several groups of 6-10 palms were lost yearly. These were destroyed as quickly as possible. but based on experimental work in 1920, it was decided to try to treat mature Oil Palms suffering from Bud-Rot. The first group treated showed surprising recoveries; at the present time no treatment of Oil Palms suffering from Bud-Rot is undertaken and only one palm has been lost over the last three years. There is no doubt about the rotting of the Bud-tissue, but equally certain is the recovery, and the set-back to the tree which naturally follows such an attack, does not appear to influence the course of normal development to any great degree. Coconut Palms do not exhibit the same powers of recovery,

but a fair number of cases have been observed, where recovery has followed treatment of diseased Coconut Palms.

Crown Disease of Young Oil Palms.

This is an affection of young Oil Palms, which in a previous report, I designated as a kind of "Incipient Bud-Rot." It is fairly common on most young Oil Palm estates The first leaf affected is the fourth from the centre; towards the base, the leaf stalk becomes soft and watery looking, and bends over at this place. Successive leaves are infected until only the youngest central leaves are standing erect. The diseased areas on the leaf-stalks, appear to be carried away from the danger zone, by the rapid growth of the palm leaves, and finally healthy leaves are produced and the palm recovers. This affection would well repay closer investigation, but as no report of the death of young palms from this cause has been received, the matter has to be left owing to pressure of other work.

Diseases of Coconut Palms Confused with Bud-Rot.

In recent years, apparently two new affections on Coconut palms in Malaya have been noted, and these symptoms are usually confused with "Bud-Rot" by Malayan planters. The affections result in a gradual lowering of disease resistance; ultimately the "Bud" becomes involved, and often the top of the tree is blown off. Several cases, however, have shown that characteristic symptoms are present, before the Bud-tissues are involved.

Symptoms No. 1

Found in most Coconut districts in Malaya. Stem-tissues are soft and discolored, characteristic salmon pink colour with patches of yellowish discolored tissue. No traces of eel-worm and no definite indications of a fungus. A white Bacillus has been isolated on two or three occasions during the last six months but no inoculations have been undertaken.

Symptoms No. 2.

Reported from one district in Malaya as doing considerable damage. Has been found near Kuala Lumpur and at Banting. Stem tissues show a characteristic hardening, all the softer ground tissue elements becoming heavily lignified The stem tissues are so hard and brittle that it is difficult to fell the trees with an axe. The vascular bundles are stained a reddish-brown colour.

Recently several trees have been found showing a combination of Symptoms Nos. 1 and 2. One case in transverse section showed a soft, outer portion, and a hardened central core, while another case showed a soft central core and the outer part of the stem hardened.

The investigation of these symptoms is proving a complicated one, for now it has to be decided whether the apparently different symptoms are but the results of the attack of one organism, or whether two entirely different diseases must be investigated.

Black Line Disease of Roots of Young Coconuts.

Specimens of diseased roots of Coconut Palms about two years old, have been examined. Faint black rhizomorphic lines were present in the attacked roots and a fungus was isolated from these roots. Preliminary inoculations show this fungus to have slight penetrative powers when placed in wounds in healthy roots. Cultures have been sent home for identification.

Fruit Disease on Oil Palms.

A rather disturbing feature has become manifest on mature African Oil Palms. On the inside of the leaf bases of large numbers of Oil Palms, close to the junction with the stem, pinkish-white rhizomorphic strands are to be found, often bearing fruit-bodies i.e. of a pink-capped Marasmius (?) sp. While commonly present, no damage is done if the fungus remains in its usual place on the leaf-bases. Recently one case has been observed where the fungus suddenly grew up over the mature fruit-bunches, and rendered them useless for oil-production. The common presence of this fungus on the palms and the possibility of the parasitic tendency becoming more common makes careful supervision necessary. It appeared that the trouble might have originated owing to the numerous, non-fecundated bunches being allowed to remain and disintegrate on the tree; usually a few mature nuts are present in such bunches, and as the fungus under consideration appears to be the chief agent in the disintegration of the non-fecundated bunches, it was possible for this organism to to get gradually accustomed to growing into and attacking the oil-bearing nuts. The suggestion to remove the non-fecundated bunches was made and carried out and there has been no further recurrence.

Sireh. (*Piper Betel*).

The above concludes the major investigation under weigh, but some work has been done on Sireh (*Piper Betel*) and interesting results obtained.

Patchouli. (*Pogostemon spp*).

A bad attack of root disease caused by *Fomes lignosus* (Kl.) on Patchouli (*Pogostemon spp.*) was reported from Singapore.

Coffee.

Much interest has been taken in Coffee cultivation and numerous diseased specimens have been sent in for examination and advice. Pressure of other work prevents closer investigation of Coffee diseases under Malayan conditions.

Jerusalem Artichokes.

Some attention has been paid to a serious disease on this crop. The causal fungus has been identified as *Selerotium Rolfsii.* (*Sacc.*)

Aleurites Montana.

Brown Root disease on this crop has been investigated for comparison with Brown Root disease on other crops. The results obtained support the suggestions made by me in 1922, i.e. that Brown Root disease of tropical crops is caused, not by a single species of fungus, but by many different morphological species, which function similarly physiologically.

GROUND-NUTS (*Arachis Hypogea.*)

Work has been undertaken at the suggestion of the Director of the Institute voor Plantenziekten Buitenzorg, respecting resistance of Javan and local varieties of *Archis hypogea* towards attacks by *Bacillus solanacearum.* Up-to-date local varities seem to be as resistant to disease attacks as the proved resistant strains from Java.

The writer has been asked by the Department of Scientific and Industrial Research to assist the Fabrics Co ordinating Research Committee in experiments relating to decay of fabrics. Thirty nine samples of cloth and yarn have been received and exposed under varying conditions

Two papers were prepared for the Imperial Mycological Conference held in London July and were read by Mr. F. T. Brooks. Other papers were published in the Malayan Agricultural Journal.

ANNUAL REPORT OF THE ENTOMOLOGICAL DIVISION FOR 1924.

By B. A. R. Gater.

Staff.

The Government Entomologist, Mr. G. H. Corbett, was in charge until May 10th, when he proceeded on leave, and also went on special duty at the British Empire Exhibition. After the exhibition he will work for a short time at the Imperial College of Science and attend the Entomological Conference in London. From the 11th May to the end of the year the Assistant Entomologist, was in charge.

The Insectary Assistant, Mr. D. Ponniah, went to India on special leave on September 18th, and reported for duty again on November 30th. Enche Mohammed Yusope, Junior Agricultural Assistant, was at head quarters during the year, and is permanently attached to this Division. I particularly desire to place on record my high appreciation of this officer's services during the period under review. Extremely hard working and enthusiastic, he forms a most valuable addition to the staff.

Organisation.

The Insectary Assistant was stationed at the Serdang Experimental Plantation as from May 1st, for liaison duties. When sufficient apparatus was available at the end of the year he was enabled to begin some investigations. The Junior Agricultural Assistant was placed in charge of the laboratory and subordinate staff. This scheme worked smoothly and enabled a larger amount of work to be completed than would otherwise have been possible.

Visits.

The visiting of estates had to be cut down, and visits were only made where a Field Officer was unable to deal with the situation. The most important visits made by the Ag. Government Entomologist were to Labuan to study the coconut Zygaenid, *Artona catoxantha*, to Penang in connection with the borers in clove trees, and to an estate where a large consignment of barrels was being destroyed by borers. In the last case the barrels which could still be used were freed of the borers (*Dinoderus Minutus, F.*) by fumigation with hydrogen cyanide, a special fumigation chamber being erected at small expense. The Seremban Gaol was visited at the request of the Medical Department with reference to a plague of house flies.

Review of Pests in 1924.

There were several outbreaks of *Artona catoxantha* on coconuts. This crop was also attacked in one or two instances by *Hidari thrax*,

Hbn., some damage being done, but all attacks were eventually controlled by parasites. *Plesispa reichei*, Chap. did some damage to young palms.

Padi was attacked by *Spodoptera mauritia*, Boisd., and *Leptocorisa* spp., the damage being fairly serious. *Cnaphalocrocis medinalis*, Guen. was responsible for extensive damage in two instances, although the padi plants eventually made a good recovery.

Among enquiries, those on the pests of coconuts, rubber, oil palm, coffee and castor predominated. A few of the more interesting examples of insects which did some damage during the year are given below :—

Termites, as usual, did considerable damage to buildings, several of which were treated on the advice of this Division. In one instance a telephone cable was damaged, the termites working through the lead outer covering, two coverings of tarred string and in between the interstices of steel tape, finally eating the paper insulation of the telephone wires.

Cantantops sp. prob. *splendems*, Thunb. did some damage to budded rubber, especially in the early stages

Among the Coleoptera, *Adoretus compressus*, Weber, and *Autoserica* sp. did considerable damage on *Terminalia catappa* and *Isoptera borneensis*, while *Hypomeces squamosus* damaged a large variety of plants, notably kapok. *Cylas formicarius*, F. was present in considerable numbers on sweet potatoes. *Apriona flavescens*, Kaup. was found boring in *Artocarpus polyphemia* as well as in Jack fruit. A Cerambycid (*Stromatiom longicorne*, *Newm*) did considerable damage to the heavy timbers in a bungalow. Two species of *Odontolabis* were reported to have damaged coconut leaves, but this was not confirmed.

Tobacco suffered severely, in some instances, from the attacks of *Heliothis flavigera*, Hamps , and *Phthorimaea heliopa*, Low., while advice was given on more than one occasion on the prevention of *Lasioderma serricorne*, F in cheroot factories.

Euproctis sp considerably damaged a cover crop, *Centrosema*. Several Lymantriids are known to feed on rubber, and there is some danger of such insects migrating from the cover to the rubber Soya beans and ground nuts were attacked by the Gelechiid, *Stomopteryx subsecivella*, Zell., while the larvae of another species of *Phragmataecia*, *P castaneae*, Hb. were found to be causing considerable damage to sugar cane, especially ratoon crops, by boring the stems.

On several occasions really serious infestations of Coccids were found on fruits such as lime and Jack-fruit, while in particular, *Saissetia nigra*, Nietn. was common on rubber, cotton and croton. Many more cases of Coccid damage came under notice than in previous years, and under plantation conditions these insects may become more serious than in the past.

Of the insects sent in for identification *Sylepta derogata* and *Maruca testulalis* together made up 46 per cent, while a very common and injurious night-feeding beetle, *Apogonia cribricollis*, only totalled 8 per cent. Damage due to the latter occurs at night and the insect is rarely noticed, while the two former insects are collected as caterpillars on the leaves, chiefly of garden plants.

MISCELLANEOUS ACTIVITIES.

Lectures were given to the Incorporated Society of Planters and to Malay Officers by the Ag: Government Entomologist. In October a course of lectures on Entomology to Malay Apprentices was started and is still in progress. In August a scheme of operations for Locust Campaigns was prepared and a memorandum sent forward with reference to certain precautionary measures necessary in the event of another locust invasion. The scheme is kept in this Division and can be issued to all concerned directly news of a locust swarm is received. The object of this is to provide a course of immediate action based on past experience and up-to-date knowledge of locusts, and so that investigations along definite lines can be started by this Division without delay. Considerable time was spent in assisting the revision of import laws relating to dangerous pests, and it was urged that greater stringency should be used in the control of imports likely to bring in the Mediterranean Fruit fly and the Coffee Berry borer. Messrs. A. M Lea and C. T. Mc. Namara arrived from Fiji with reference to *Levuana iridescens*, Baker, and endeavours were made to help them in the control of the pest by means of parasites from this country. The position was discussed with them and they were given the latest information available about the parasites they wished to import into Fiji.

PUBLICATIONS.

During the year the following publications were issued by the Division, two, concerning *Artona catoxantha* and a list of economic insects in Malaya, being unavoidably held over until 1925:—

1. "The Two-coloured Coconut Leaf beetle (*Plesispa reichei*, Chap.)" Bulletin No. 34.

2. "*Scotinophara coarctata*, F." Malayan Agricultural Journal, Vol. XII No. 4.

3. "*Batrachedra arenosella*, Wlk. in relation to the Nut-fall of Coconuts." Malayan Agricultural Journal, Vol. XII No. 5.

4. "Annual Report for 1923" M. A. J. Vol. XII No. 8.

5. "The Red stripe Weevil of Coconuts (*Rhynchophorus schach*, Oliv.)" Bulletin No. 36.

6. "Insect Pests of Labuan and Adjacent Islands." M. A. J. Vol. XII No. 11.

INVESTIGATIONS.

The policy of the Division during the year has been to continue in the amassing of a general knowledge of the insect pests of Malaya rather than to make a number of comprehensive studies.

During the year 1107 batches of insects were taken through the breeding cages, representing rather over 6000 individual insects handled by the Division. Of the batches, 15% were parasites, most of which are new to science. Among the pests of crops a number of insects was found to be new, and some have been described by Systematic specialists. Investigations on individual pests had to be curtailed owing to shortage of staff, attention being directed only to the more important. Considerable work was done on *Artona catoxantha*, the insects affecting the oil-palm, and on derris. The life histories of several pests were worked out roughly and a start was made on a study of the Coccidae of Malaya. Efforts were also made to investigate the position of silk as a possible industry in Malaya.

SOME PRELIMINARY RESULTS.

Artona catoxantha, Hamps. Work was mainly concentrated on the parasites, of which eleven have now been discovered, in addition to one predaceous insect and the fungous parasite. Of the parasites the most important is a Tachinid, which was described by Dr. Aldrich as *Ptychomyia remota*, new species. *Ptychomyia remota* has been bred on two other caterpillars besides *catoxantha*, and its life history has been roughly worked out. Seven hyper-parasites have been discovered on this insect. Attempts at keeping the pupae of this Tachinid in cold storage for any length of time failed, but it is proposed to conduct a series of investigations on the temperatures influencing it as soon as more material is available. Some striking instances of the apparent influence of fires under coconut trees in inducing outbreaks of *Artona catoxantha* were observed, and meteorological influences were also studied. In one instance *Ptychomyia remota* was taken to Labuan where an outbreak of *catoxantha* was in progress, and where the Tachinid parasite were absent. A summary of observations on *Artona catoxantha* will be published early in 1925.*

Insects affecting the Oil-palm. In addition to insects already reported, the following were found feeding on Oil-palms during the year:—

Anomala dorsalis, F. *Hidari thrax*, Hbn.,

Aleurocanthus gateri, Corbett., & *Setora nitens*, Walk.

Among the insects which have not yet been identified are several Limacodids feeding on the leaves, a Lymantriid caterpillar which eats the young fruits and the larva of a minute moth which may be found in large numbers feeding on the male flowers. Whether the last named is instrumental in killing the flowers and preventing the

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*See M.A J. Vol. XIII No. 4.

spread of pollen, or whether it comes in just after the flower has shed its pollen is not yet certain.

The fact that large numbers of insects are seen round the flowers of African Oil-palms has led certain people to believe that hand pollination might be dispensed with by the cultivation of bees. An investigation was started to ascertain what effect insects had on the pollination, and preliminary results indicate that they have little if any influence. An area of nineteen trees was kept under observation for a month and all insects visiting the flowers were caught daily. In this manner 694 insects were caught at the flowers, but not in a single case was one caught or seen on the female flowers, their attention being exclusively devoted to the pollen.

Derris. Owing to difficulties in the identification of the species of *Derris* the position is in many ways hardly advanced from last year. From tests conducted on insects it appears that there are considerable differences in the toxicities of the various derris plants, but the unreliability of native names has rendered any accurate work impossible. Very shortly however, it is hoped that properly identified plants will be available for study. Some of the plants called "Tuba" in Malay are not *Derris*, but a good collection has been made of all plants said to be poisonous to fish. The number of insects found feeding on the leaves of Derris is considerable, and may influence the production of these plants on commercial lines. The following have been found on the leaves :--

Hesperiidae : --*Hasora alexis*, F. Arctiidae :—*Amsacta lactinea*, Cram. Geometridae :—*Anisodes obrinaria*, Guen. Limacodidae :— *Belippa laleana*, Moore. Thyrididae: --*Striglina scitaria*, Wlk. Pyralidae : *Maruca amboinalis*, Feld., *Lamprosema diemenalis*, Guen. Eucosmidae :—*Eucosma defensa*, Meyr., and *E. balanoptycha*, Meyr. In addition to these some roots have been found badly damaged by borers but as yet they have not been investigated.

Epilachna indica, Muls. This insect causes considerable damage at times to brinjal, *Datura stramonium*, *D. metels*, french beans and cucurbits. It has also been found feeding on rubber. Females emerging in the laboratory began laying after an interval of 8 days. The eggs hatched after 14 days and the larvae pupated 18 days later. Emergence took place after a further period of seven days, making a total of 39 days from egg to adult. There were three moults during the larval life, the fourth moult giving the pupa. The duration of instars was 3, 5, 4 and 6 days respectively. Another species of *Epilachna*, *E. 28-punctata*, F. var. *pubescens*, Hope, was discovered of on ladies fingers. No parasites have as yet been found on either of these species.

Piezodorus rubrofasciatus, F. (Pentatomidae)—was found in considerable numbers on *Sesbania aculeata* and *Cajanus indicus*. Copulation took place four days after emergence, eggs being laid in

batches of about thirty after an interval of twelve days. The eggs hatched in six days. There were five moults, the period being 7, 5, 3, 6 and 5 days, making a total period of 32 days from egg to adult. No parasites have been observed.

Creatonotus transiens, Walk. is an occasional pest of ragi, vanilla and ground nut. The rate of reproduction is large and the number of food plants is probably not limited. One female laid 1525 eggs in four batches over a period of 4 days. These hatched after 5 days, the larval period varying from 27 to 35 days. The pupal period lasted from 6 to 9 days. For the first three days the larvae skeletonise the leaves only, and they cease feeding two days before pupating. No parasites have been observed.

Brithys crini, F. This Noctuid was found to be doing some damage to *Zephyranthes* and subsequently fed on beans. The largest number of eggs laid by one female was 568. Laying took place two days after emergence, the eggs hatching in 6 days. The larval and pupal periods were from 18 to 22 days and 11 days respectively. During the early part of its life the caterpillar bores the stem, emerging later and feeding on the outside. On beans the green pod seems to be preferred. No parasites have been recorded.

Nygmia scintillans, Walk. is an omnivorous insect which is fortunately fairly well controlled by parasites. It has been found feeding on the following plants :--

> Castor, ladies fingers, rubber (flowers), candle nut, *Sesbania aculeata*, vanilla, *Aleurites montana*, dadap, cowpea, soya beans, *Eugenia aquea*, *Sesbania grandiflora*, *Pithecolobium dulce* and cabbage.

Up to 233 eggs were laid in batches of varying numbers during a period of 6 days, oviposition starting in from one to five days after emergence. The eggs hatched in five days ; the larval period was 18 and the pupal period 9 days. The larvae are parasitised by three hymenopterous insects. As many as 22 larvae of Chalcidoid No. 1412 emerged from one caterpillar and pupated next day, the pupal period being 6 days. Braconid No 1418 emerges from caterpillars after the latter have spun their cocoons. Seven have emerged from one caterpillar.

Psara submarginalis, Swinh. This Pyralid is chiefly a pest of tobacco, but has also been found feeding on lettuce and cabbage. Eggs are laid five days after emergence in small numbers over varying periods, up to 69 eggs having been laid by a single female. The eggs hatched in five days and the larval period was from 16 to 20. The pupal period took from 5 to 6 days. An hymenopterous larva was seen in one of the caterpillars but did not survive.

Agromyza sp. prob. *sojae*, Zehnt. No. 1369. The larvae of this minute fly appear to be a limiting factor in the cultivation of

Soya beans. At Serdang certain varieties* showed a difference in susceptibility to attack, one being regularly killed while the other produced a fair stand. This insect has also been found attacking other beans such as french and velvet. Control measures were attempted by means of sand mixed with 3 per cent crude fuel oil, and calcium cyanide. The first prevented the flies ovipositing to a certain extent, but was of little use. Tar oils, which would probably be much more efficient were not obtainable. The calcium cyanide was much more successful but was not applied correctly. Heavy rain fell soon after the application, carrying hydrocyanic acid down to the roots and killing the adjacent rows. The untreated rows down wind, however, were remarkably free from the fly, suggesting that in a country with heavy rains the calcium cyanide should be placed some distance from the beans in the direction of the prevailing wind. Eggs are laid in small cracks in the epidermis of the stems of seedling beans, up to 10 eggs having been observed to be laid at one time. Twenty six larvae have been counted in one plant. The eggs hatched after an interval of about 5 days. All the larvae died in captivity and the larval life was not worked out. Pupal period 8 days. Copulation takes place in from one to three days after emergence.

Two parasites which emerged from the pupae of the fly were discovered, Chalcidoids Nos. 1373 and 1379.

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* Known at the Experimental Plantation as Pahang No. 1 and Pahang No. 2 respectively.

ANNUAL REPORT OF THE AGRICULTURIST, FOR THE YEAR 1924.

By J. N. Milsum.

THE Agriculturist (Mr. F. G. Spring) went on leave on 23rd May, Mr. J. N. Milsum (Ag. Agriculturist, Government Plantations) acted as Agriculturist from that date, in addition to his other duties.

Mr. E. Farquharson (Assistant Agriculturist) assisted the Agriculturist generally at Kuala Lumpur. This officer left the service on 29th August and was succeeded by Mr. H. D. Meads (Temporary Superintendent, Government Plantations.)

Mr. E. Mathieu (Superintendent, Government Plantation) was in charge of the Experimental Plantation and Astana Grounds, Kuala Kangsar.

The Agriculturist acted on the Committee for the management of the Batu Caves Settlement and was Honorary Secretary of the Gardens Committee, Kuala Lumpur during the year.

Experimental Plantations.

The following shows the expenditure and receipts from the Experimental Plantations at Kuala Lumpur and Kuala Kangsar during the year.

Total Upkeep Expenditure, Experimental Plantation, Kuala Lumpur	...	$20,883.77
Total Upkeep Expenditure, Experimental Plantation, Kuala Kangsar	...	5,525.61
Receipts of Rubber Sold	...	6,693.32
,, Plants and Seeds Sold	...	3,134.89
Miscellaneous Receipts	...	190.62
Total Receipts	...	$10,018.83

The amount of Rubber in Store at the end of the year was approximately 636 lbs.

At the Experimental Plantation, Kuala Lumpur, a considerable amount of work was undertaken in connection with terracing and turfing banks and edgings of roads. An avenue of shade trees, (*Peltophorum ferrugineum*) was planted at Swettenham Road, which divides the Plantation. Experimental tapping only was continued and almost the entire crop harvested was disposed of by the close of

the year. The area under rubber was gone through systematically and all necessary pruning attended to.

The Brazil Nut trees continued to make good progress and ten of the largest trees have reached the fruiting stage. From these trees, 165 pods fell and were collected during the year. The nuts were sown in nursery beds and those that germinated were either distributed to applicants or forwarded to the Experimental Plantation, Serdang, for the purpose of planting up an area there. Experiments with germination show that satisfactory results may be obtained by planting the nuts in hot sand-beds as in the case of oil palm seeds. The larger trees were measured at 3 feet from the ground, the average girth was found to be 2' 9," while the largest was 5' 7".

The nuts collected are of good size and flavour and it is considered that the Brazil Nut tree is an introduction of real value.

The work at the Kuala Kangsar Experimental Plantation was mainly in connection with minor crops, and is referred to later in this report.

General Agriculture.

A large number of enquiries were received, as usual, and dealt with. In addition to Rubber and Coconuts, interest was shown in the following crops: —Oil Palm, Tapioca, Coffee, Gambier, Areca Nut, Tuba Root, Patchouli, Pineapple, Kapok, Nipah palm and Fodder Crops.

Rubber.

At the commencement of the year the London Price of ribbed smoked sheet was 1/2 pence per lb. with a local price of 49 cents per lb. The price fell to 10 pence (London) and 31½ cents (local) in May, but rose in the latter half of the year, reaching 1/7⅞ pence (London) and 68 cents (local) in December. The exports of rubber from the F.M.S. for 1924 was 93,507.051 tons as against 101,310.8 tons during 1923.

Coconuts.

The price of copra was $12.50 per picul in January, sinking to $10.50 in April and recovering to $13.65 in late October. At the close of the year the price stood at $13/–. The exports of copra from the F.M.S. for the year was 55,197.1 tons valued at $9,641,012 as against 49,037 tons value $8,190,701 for 1923.

Oil Palms.

Considerable interest in the possibilities of this palm as a large-scale plantation crop was shown. At the end of the year between 5,000 and 6,000 acres of oil palms had been planted in Malaya. This acreage is likely to increase very materially in the near future. During the later part of the year, a modern plant for the extraction of oil was installed on an estate in Selangor. Approximately 295 tons of Oil and 40 tons of Kernels were exported from the F.M.S.

during 1924, as against an almost similar monthly production from the East Coast of Sumatra.

COVER CROPS ON ESTATES.

The use of cover crops is becoming more general and considerable attention was given to this subject at the Experimental Plantations. Circular No. 4/24 was issued by the division as a guide to Planters. At the Experimental Plantation, Serdang, almost thirty cover and green manure plants are under trial but of these, the following are so far considered to be the most suitable.

Purpose.		Plant.
Cover for open clearings.	-	*Centrosema Plumieri.* *Calopogonium mucunoides.*
Cover under shade.	-	*Vigna Oligosperma.* Sarawak bean.
Soil renovators.	-	*Tephrosia candida.* "Boga" *Crotalaria usaramoensis.*
Green manure. (for turning into the soil)	-	*Dolichos biflorus.* Horse Gram.

In opening up new clearings on hilly land, with the use of sufficient silt pits in contour and a strong growing cover crop as *Centrosema Plumieri* or *Calopogonium mucunoides*, almost all surface erosion may be prevented.

TAPIOCA.

The cultivation of this important crop continues, mainly in Pahang, and outside the Federation in Kedah and Malacca. The exports from the F.M.S. alone during 1924 are as under: —

		Tons.	Value.
Flake	...	2016.6	$331,349
Flour	...	347.0	16,169
Pearl	...	422.14	72,546
Ampas (factory waste)	...	1553.35	20,394

COFFEE.

An improved market has resulted in increased interest in Coffees. Generally, the Liberian type has been found to succeed best, but Robusta is grown with success in some districts. Its possibilities as an export crop do not seem very great, having in view the serious competition from Java, and increased planting of the Robusta types in Uganda and other parts of Africa.

ARECA NUTS.

Interest has been shown in this crop and attention is being given to the possibilities of its further cultivation. The exports from the F.M.S., during 1924 were 1412.7 tons valued at $249,225.

OTHER CROPS.

As catch crops, Gambier, Tuba Root, and Patchouli have been planted. The price of Gambier has been comparatively high and with suitable conditions i. e , spare labour and plenty of fuel, this crop appears worth consideration.

The market for Tuba Root is uncertain and until satisfactory outlets for this crop are found, its cultivation cannot be recommended. Exports from the F.M.S. during 1924 amounted to 23,431 lbs.

The Ag. Agriculturist served on a Sub-Committee of the Department in connection with Nipah Palm cultivation and some attention has been given to the possibilities of this palm as a large scale crop for coastal and tidal areas. About 800 acres have been planted in Selangor and so far the growth and behaviour of the palms under cultivation has been satisfactory.

Experimental tapping carried out by the Chemical division at the experimental block at Jeram, shows promise of Nipah as a satisfactory source of power alcohol and sugar. Further developments with this palm in Malaya will be of interest but as yet it is a matter of uncertainty whether there is sufficient land or natural areas for any considerable extension.

PINE-APPLES.

A visit was made to several Chinese Pineapple Estates in Johore and the system of cultivation and packing examined. Three problems, connected with this crop, require attention, namely, improved packing, variety of Pineapple, and crop rotation. An important consideration in marketing tinned fruits, is an attractive container, and should it be found possible to export a higher class Pineapple than at present, a distinctive label and careful packing will do much to popularise Pineapples from this country.

A large number of pineapple varieties have been secured from various sources and the experimental trial of these on a field scale at the Experimental Plantation, Serdang, is work of considerable importance.

The treatment of land after cropping with pineapples is a difficult problem, the usual system in the past being to interplant rubber. A suitable rotation or methods of bringing the land back to a sufficient state of fertility is a very necessary adjunct to the culture of a crop of this nature and it is hoped to be able, at a later date, to make recommendations, based on experimental work in progress. The export of tinned pineapples from the F.M.S. for the year was 3,949 tons value $732,190.

SISAL HEMP.

The Ag. Agriculturist served on a Departmental Fibre Committee and considerable work was undertaken with Sisal Hemp. The results were published in the November number of the Malayan

Agricultural Journal. It is sufficient here to say that this crop is well suited to Malayan conditions and might equally well be grown profitably in this country as in Sumatra, which country is now exporting over 1000 tons of fibre a month.

Investigations are in progress to ascertain the possibilities of this crop as a rotation following Tapioca.

Long-Staple-Cottons.

Small plots of Sea-Island and Egytian Cottons were tried at the Experimental Plantations, at Kuala Lumpur, Kuala Kangsar, and Serdang. The results from the latter Plantation are included in the report of the Ag. Agriculturist, Government Plantations, for 1924. In all cases these cottons failed completely and I consider it an unsuitable crop for this country, at least on the Western side of the Peninsula.

Fodder Grasses.

Investigations were carried out during the year, mainly at Serdang, and a paper on the subject was published in the December number of the Malayan Agricultural Journal. A Circular (No. 3 of 1924) was issued and distributed; this has resulted in numerous enquiries for planting material. As a cut fodder, Guinea grass has proved most satisfactory and 62,000 plants were distributed. Carpet grass recently introduced by the division from America, has proved an excellent general utility grass and a large amount of material was distributed. A paper on this grass was contributed to the Malayan Agricultural Journal, Vol. XII, No. 12, December, 1924.

Annual Crops.

Lima beans, Soya beans, Ground Nuts, Tobacco and Maize were cultivated at the Experimental Plantation, Kuala Kangsar, Mr. Mathieu succeeded in growing remarkably good crops of these, but it is a matter of considerable uncertainty whether the cultivation of most annual crops is likely to be profitable on other than a small scale. The rainfall experienced at Kuala Kangsar (68.5 inches during 1924) was comparatively low and in addition the soil is particularly suited to the cultivation of such crops. It is to be appreciated that the conditions of the greater part of the Peninsula are essentially those of a rain forest country, i. e., a heavy rainfall distributed throughout the year with uncertain seasonal variations. This, combined with the comparatively poor soils and numerous insect pests, makes the cultivation of annual crops, excluding Padi and Maize, a matter of considerable uncertainty. Present investigations indicate that such crops must be considered in the nature of market gardening, requiring intensive culture. Possible exceptions are Ground Nuts and Gingelly which under suitable conditions frequently yield good returns. The import into the F.M.S. of Ground Nuts is so heavy that it is curious that this crop is not cultivated in quantity. This, however, may be

due to the comparative smallness of the population in the Peninsula. The imports for 1924 are as follows :—

		Tons.	Value.
Ground Nuts	...	1070	$ 194,788
Ground Nut Oil	.	2531.25	1,189,791
Gingelly Seed	...	26.45	103,298

FRUITS.

A large number of fruit trees were raised at the Experimental Plantation, Kuala Lumpur, and distributed during the year. Arrangements have now been made to transfer this work to the Experimental Plantation, Serdang, with the object of fruit improvement and distribution of selected stock.

GENERAL.

A number of visits were made to Estates and advice given on matters of general agriculture. A visit was made to the farm attached to the Central Mental Hospital, Tanjong Rambutan, Perak, where highly satisfactory results are obtained in the cultivation of a variety of food crops. This institution has been supplied with a considerable quantity of planting material. Visits were made to Fraser's Hill, Pahang, and horticultural plants supplied for planting on the Hill Gardens.

Note :—The Customs Department, Federated Malay States, has kindly supplied the export figures in this report.

ANNUAL REPORT OF THE AGRICULTURIST, GOVERNMENT PLANTATIONS FOR 1924.

By J. N. Milsum.

Mr. B. Bunting, Agriculturist, was in charge of the Government Plantations; Pondok Tanjong, Kuala Tembeling, Castleton Estate, Telok Anson, the Coconut Plantation, Sapintas, and the Experimental Plantation, Serdang, until he went on leave on the 26th April, when Mr. J. N. Milsum, Assistant Agriculturist, took over the acting appointment.

Mr. T. D. Marsh, Assistant Agriculturist, was stationed at Castleton Estate, Telok Anson

Messrs. E. A. Curtler, Assistant Agriculturist, and J. Lambourne, Superintendent, Government Plantations, assisted at the Experimental Plantation, Serdang.

Mr. J. N. Milsum returned from leave on the 29th March.

Mr. J. Lambourne was promoted to the appointment of Assistant Agriculturist as from 1st October.

Expenditure and Revenue.

The following shows the expenditure and revenue, of the Government Plantations, during the year under review.

Expenditure.

Government Plantation, Pondok Tanjong	...	$35,761 80
,, ,, Kuala Tembeling	...	18,688 98
,, ,, Sapintas	...	49,133.88
Castleton Estate, Telok Anson	...	29,551.36
Experimental Plantation, Serdang	...	91,388.41
Total	...	$221,774.11

Revenue.

Government Plantation, Pondok Tanjong	...	$60,114.02
,, ,, Kuala Tembeling	...	7,975.49
,, ,, Sapintas	...	12,596.16
Castleton Estate, Telok Anson	...	15,708.25
Experimental Plantation, Serdang	...	1,089.44
Total	..	$127,483.36

The total expenditure of the Government Plantation for the year was $224,774.41 as compared with $200,536 12 in 1923, which is an increase in expenditure of $24,238.29, whilst the total revenue for the year was $127,483.36 against $88,342.59 in 1923, or an increase in revenue of $39,140.77.

The Government Plantations at Pondok Tanjong, Kuala Tembeling and Sapintas ceased to be supervised by the Department at the end of the year and were placed under the management of the Planters' Loans Board, F.M.S., as from 1st January, 1925.

The divisions of the Government Plantations, F.M.S. and Agriculturist, S.S. & F.M.S. were then reorganized Mr. Bunting being placed in charge of the "Agriculturist" Division with Mr. J. N. Milsum acting until the former's return from leave, while Mr. F. G. Spring was placed in charge of the Division of Agriculture "Rubber."

Government Plantation, Pondok Tanjong.

Mr. F. M. McCormac was in charge of the Plantation until 29th May when he went on leave. Mr. C. Gwatkin Williams was appointed Manager as from that date and remained in charge during the remainder of the year.

The area of the Plantation is approximately 307 acres, made up as follows:—

Mature Rubber	...	293	acres.
Building Sites	...	7½	,,
Waste Land	...	6½	,,

The New Clearing (300 acres, unplanted) was sold by Public Auction on the 21st January, 1924, for the sum of $36,000 -.

The plantation has been maintained in good order and attention given to the removal of all untappable trees. The drains throughout the estate have been cleared periodically and all bridges kept in good repair.

The labour force at the end of the year was 54 males, 21 females and 27 minors, a total of 82 Indian coolies. The average daily wage was 41.68 cents per day.

The health of the labour force has much improved, there being 81 admissions into hospital against 139 last year. There were three deaths, two occuring in Taiping Hospital. One coolie was killed on the plantation by a tiger.

The tapping system has remained the same as in 1923, i.e., one cut on a quarter alternate day except Fields 2, 4 and part of 5, which is a single cut on a third on alternate days.

At the close of the year there were 18,538 trees being tapped out of a total of 23,256. The average stand of trees per acre was 79.6.

The crop for the year was 80,897 lbs. of dry rubber, comprising 84.63% No. 1 Ribbed Smoked Sheet and 15.37% lower grades. The cost of tapping and collecting was 4.38 cts. per lb. as against 5.14 cts. in 1923. The "all in" costs for the year were 36.9 cts. per lb.

There were fifteen consignments forwarded to the Singapore Auctions during the year and many gained the Standard Award for Smoked Sheet. The average price realised for the year was 48.73 cts. per lb.

Diseases and pests have, as usual, been troublesome, but have been kept well in hand.

It was an abnormally wet year, rain being recorded on 208 days, registering a total of 156·19 inches as against 127.69 inches in 1923.

GOVERNMENT PLANTATION, KUALA TEMBELING.

Capt. F. J. Ayris was Manager of the plantation throughout the year.

The area of the plantation is approximately 930.62 acres, which is made up as follows :—

Mature Rubber	...	350 98	acres.
Immature Rubber	...	93.17	„
Clearings (not planted)	...	22.37	„
Building Sites	...	9.11	„
Reserve Land	...	454.99	„

No tapping was undertaken during the year.

The two cover plants (*Centrosema Plumieri* and *Vigna oligosperma*) in the mature areas continued to do well, the latter cover having always been very successful on this plantation, even under heavy shade.

The labour force at the close of the year consisted of 39 males, 10 females and 1 minor or a total of 50 Tamil coolies.

It was found necessary to reduce the labour force during the latter part of the year to keep the expenditure within the estimate.

The general health of the coolies was fair. There were 48 admissions to hospital and two deaths during the year.

It was found necessary to undertake considerable repairs to lines and other estate buildings and, with the exception of the Manager's bungalow, all buildings were in good order and repair at the close of the year.

Disease was kept well under control; a number of cases of Pink disease (*Corticium salmonicolor*) receiving the necessary attention.

During May and again in July considerable damage was done by elephants, 74 dwarf coconut palms being destroyed.

Rain was recorded on 190 days during the year, giving a total rainfall of 92.44 inches.

CASTLETON ESTATE, TELOK ANSON.

Mr. T. D. Marsh, Assistant Agriculturist, was stationed at Telok Anson, and was in charge of the estate during the year.

The area of the estate is 207 acres, 2 rods, 35 poles, which is made up as follows :—

Mature Rubber	...	196.9	acres.
Coconuts	...	6.8	„
Building Sites	...	4.5	„

The cost of weeding the whole estate, other than the area under cultivation experiments, was $2.95 per acre or 24.58 cts per acre per month. This figure includes weeding in the coconut area and manurial experimental block, which areas produce a rather heavy growth of weeds.

The labour force at the close of the year consisted of 76 Tamil coolies. The average daily check-roll wages throughout the year was 39.85 cts. per coolie.

The general health of the labour force was good. There were 8 admissions to hospital during the year and of these three died. Two deaths were due to digestive trouble with infants and in one case the child of a new coolie died of malaria.

General repairs were carried out to buildings and all were in good repair at the close of the year.

The estate was tapped throughout the year on one cut on a quarter daily, with the exception of the two experimental plots which were tapped on a V alternate days. The total number of trees at the close of the year was 15,477 or an average stand of 75 trees per acre, excluding the 19 6 acres under a thinning experiment where there is an average of 114 trees per acre. A total of 330 trees were removed during the year of which 307 were cut out during the process of thinning. The remaining 23 were removed owing to disease.

The amount of dry rubber harvested during the year was 93,570 lbs. as compared with 83,437 lbs. in 1923. The average yields during 1924 and 1923, are as follows :—

		1924.	1923.
Yield per tree per annum	...	6 lbs.	5.21 lbs.
Yield per acre per annum	...	475 „	423 „

The average cost of tapping and collecting, including utensils, was 6.84 cts. per lb. against 7.49 cts. per lb. in 1923. This comparatively high cost is due to the experimental work limiting the number of trees tapped per coolie. The "all in" cost of production was 27.81 cts. per lb. as compared with 28.50 cts. in 1923

The crop harvested was sold at the Singapore Auctions and the average price realised for all grades was 48.27 cts. per lb as against 46.83 cts. in 1923.

A new Semi-Diesel Tangye, 30 h.p. engine was purchased through the Crown Agents, London, and installed in February. The installation of the new engine resulted in a considerable saving in charges under manufacture. The cost of coagulation and manufacture during the year was 3 67 cts. per lb. against 5.16 cts. per lb. for 1923.

The drains throughout the estate have been cleared and where necessary deepened. A number of new subsidiary drains were cut in the manurial plots. The whole of the estate is now thoroughly drained.

The various experiments as under the following headings were continued throughout the year.

Cultivation Experiments.—Various experiments with cultivation covering 30 acres have been recorded continuously since March 1913.

Tapping Experiments.—Right and left tapping experiments were commenced in December, 1915, and continuous records have been taken.

Alternate day tapping —Yields from daily versus alternate day tapping and early tapping versus late tapping are recorded.

Individual Yields -Yields have been recorded from 100 old trees for the past two years and four months.

Thinning Experiments - -These experiments over about 10 acres were commenced in January 1917.

Manurial Experiments.—The results from a number of manurial experiments over an area of 40 acres were completed during the year. A fresh manurial experiment over 47 acres was laid down early in the year and the necessary data recorded.

The land under coconuts was planted with a variety of cover plants to provide demonstration plots.

A change of tapping was decided on for 1925 and it is anticipated that with a more conservative system, the affected trees will gradually recover and the disease be less prevalent. A few trees were lost through *Sphaerostilbe repens.*

Rain fell on 191 days during the year, giving a total rainfall of 101.36 inches. The wettest month was November with a rainfall of 14.51 inches. The heaviest rainfall in a day was 3.80 inches on November 6th. The dryest month was August with a rainfall of 1.40 inches.

Government Coconut Plantation, Sapintas.

Mr. F. G. Parkin, Manager, returned from leave on the 10th January and took over charge from Mr. R. R. Hartley as from that date.

The area of the plantation is 2,122.5 acres, which is made up as follows:—

Coconuts	...	973.4	acres.
Rubber	...	88.6	,,
Cleared but not planted	...	40.0	,,
Felled and part cleared	...	56.1	,,
Building Sites	...	17.3	,,
Waste Land	...	45.5	,,
Reserve Jungle	...	901.6	,,

A census of bearing and flowering palms was taken in July showing the following figures:—

Palms in bearing	...	13,241	
Palms in flower	...	6,014	
Acres in bearing	...	251	acres.
Total acreage	..	938.1	,,
Immature acreage	...	35.3	,,

A census of rubber trees was taken in July showing 5,545 tappable trees as against 1,370 in 1923.

The experiments with various legumes and other plants as cover crops were continued, the following plants being tried out for this purpose:—*Centrosema Plumieri*, *Mimosa invisa*, *Clitoria cajanifolia*, *Vigna oligosperma*, *Tephrosia candida*, *Tephrosia Hookeriana var. amoena*, *Passiflora foetida* (Passion flower) and *Ipomoea batatas* (Sweet Potato). The area under experiment, including the 4 clean weeded controls, was approximately 72 acres.

The roads have been kept clean, and the bridges in good repair during the year.

Considerable attention was given to the drainage system, and where necessary the drains were cleaned out and deepened.

The new water-gate in Fields 3/4 had not been completed at the end of the year.

Fresh seedling palms were supplied, a total of 2,480 have been planted during the year.

Pigs and bears have been a source of trouble, the former destroyed a number of young seedlings, and the latter a number of large palms on the South and West boundary fields. White ants continued to give trouble but were kept well in hand. Several palms were destroyed by beetles and bud-rot.

The labour force at the close of the year consisted of 150 men, 56 females and 35 minors; a total of 241 Tamil coolies.

The average daily check-roll wage for the year was 37.65 cts. per coolie.

All buildings were kept in thorough repair during the year. A Ceylon pattern brick copra kiln capable of dealing with 3,750 nuts a day was completed in July. The kiln has proved very satisfactory and first quality copra is now made. A cement floor for use in splitting the nuts and preliminary drying was also completed.

A crop of 380,038 nuts was made into copra, realising 1,387 piculs, 81 katties nett copra. which sold for an average price of $11.79 per picul. The average number of nuts to the picul was 26.9 which included a number of nuts from dwarf palms. A total of 1,319 nuts was sold locally. The total amount realised for the sale of copra and nuts was $16,357.83 against $8,939.48 in 1923. The average cost of harvesting and manufacture of the copra was 73 cts. per picul. Since the new kiln was used, a considerable reduction in cost was effected.

Rain fell on 168 days, giving a total rainfall of 90.08 inches against 84.28 inches in 1923.

EXPERIMENTAL PLANTATION, SERDANG.

The object of the plantation is the testing out of all crops, other than rubber, coconuts and padi and the supply of planting material of economic plants in the Peninsula. In addition, it is proposed to transfer to Serdang the work on fruit, previously carried out at the Kuala Lumpur, Experimental Plantation. It is also proposed to commence preliminary work on Stock Farming early in 1926.

Two Assistant Agriculturists were stationed on the plantation during 1924 and it is proposed to increase the European staff to four, though leave arrangements will result in one such officer being absent for the present.

A list of crops and other economic plants established at the Experimental Plantation at the close of the year was published in the Malayan Agricultural Journal (Vol. XIII, No. 1) and also issued as

Departmental Circular No. 1/25. The list comprises 165 species of plants.

The following crops are those considered of major importance and of possible suitability as plantation crops on the plains in this country.

LIST OF MAJOR CROPS.

Tapioca	...	Manihot utilissima
Pineapple	...	Ananas sativus.
Coffee	...	Coffee spp.
Oil Palm	...	Elaeis guineensis.
Sisal Hemp	...	Agave sisalana.
Clove	...	Eugenia caryophyllata.
Nutmeg	...	Myristica fragrans.
Gambier	...	Uncaria Gambier.
Areca Nut	...	Areca Catechu.
Tuba	...	Derris elliptica.

Research work on fodder grasses was undertaken during the year and the results obtained were published in the Malayan Agricultural Journal (Vol. XII No. 12). The following grasses have proved so far the most suitable fodders under trial.

FODDER GRASSES.

Guinea Grass	...	Panicum maximum.
Napier Grass	...	Pennisetum purpureum.
Mauritius Grass	...	Panicum muticum.
Dallis Grass	...	Paspalum dilatatum.
Carpet Grass	...	Axonopus compressus.

Attention was given to the food crops of the Peninsula, other than padi and garden vegetables. The following list shows the most important food crops that were under trial.

FOOD CROPS.

Greater Yam	...	Dioscorea alata.
Lesser Yam	...	,, esculenta.
Ragi vars :	...	Eleusine coracana.
Sweet Potato vars :	...	Ipomoea Batatas.
Tapioca vars :	...	Manihot utilissima.
Maize vars :	...	Zea Mays.
Groundnut vars :	...	Arachis hypogaea.

The area of the plantation is approximately 1,525 acres of which 570 acres had been opened up by the end of the year. Provision has been made in the 1925 Plantation Estimates for a detailed survey of opened area.

The following more important crops were planted up during the year under review:—Coffee 3½ acres, Groundnuts 8 acres, Gutta-percha 1 acre, Tapioca 5 acres, *Elateriospermum Tapos* (Prah) 5 acres, Manila Hemp 10 acres, Caraguata fibre 4.66 acres (part of 10 acre block), Tuba root 4½ acres, *Acacia farnesiana* 1 acre, Mauritius grass 1 acre, Sago palm 3 acres, Oil palm 17 acres, Sisal Hemp 8½ acres (part of 10 acre planting distance experiment plot). An area of approximately 5 acres of "blukar" adjoining the Kapok area was cleared in preparation for planting lowland tea. Seed of four "jats" of tea were obtained from Assam and raised in the nursery.

Approximately 100 young trees of economic importance were planted in the arboretum during the year.

Fifty four species of plants were introduced, including three new cover plants and two fodder grasses which show considerable promise. Five varieties of tapioca were received from Java and nine additional varieties of pineapples. Seed of ten selected varieties of Coffee were purchased from Java, and a large number of seedlings are available for planting out in 1925.

The following experiments with oil palms were commenced but definite results were not available at the close of the year:—artificial pollination, pruning, germination.

To test the effect of tapioca on land as a crop, the following experiment has been started:—

A block of flat land has been divided up into ten areas of 1 acre each. The land is planted with tapioca cuttings at the rate of two acres a month to facilitate harvesting. Eight acres have been planted to-date.

Previous to planting, samples of soil from each block were collected by an officer of the Chemical division for the purpose of analysis. This work is in hand.

As the first crop of roots is taken off the land, a further planting programme will be instituted, accompanied by experiments in manuring, both artificial and by means of green dressing. In course of time, information on the following points should become available.

(*a*) Constituents taken from the land by tapioca.

(*b*) Number of crops and yield possible on the same land without manuring.

(*c*) do with artificial manuring.

(*d*) do with green manuring.

(*e*) Suitable rotations.

(*f*) Yield and subsequent crops of tapioca after rotation.

It is proposed to duplicate this experiment on hilly land.

Large consignments of Sisal, Pineapple, Mauritius and Caraguata leaves and a few stems of Manila Hemp were sent in to the Chemical division for the purpose of preparation of samples for valuation and report.

A large quantity of planting material was forwarded to headquarters for distribution to applicants and use by officers of the Department. At the end of the year arrangements were in hand to distribute planting material of Groundnuts, Pineapples and Sweet Potatoes to Malay small-holders throughout the Peninsula, the officers of the Inspection Division acting as distributing agents. The material was sent out late in 1924 and in January of 1925. It comprised 460 lbs. of Groundnuts, 7,460 Pineapple suckers and 2,060 lbs. of Sweet Potato tubers.

The Public Works Department completed the new entrance road to the plantation in March. This is a great improvement on the old road through Serdang Estate and has shortened the distance considerably.

Further progress was made in the construction of connecting roads on the plantation. The majority of such roads west of the central avenue have been completed. An avenue of Rain trees was planted along the central road. Culverts and concrete pipes have been laid to carry the roads over drains where necessary. The entrance road and main avenue were joined up. This has added very considerably to the appearance of the plantation which is now taking definite shape.

A considerable amount of drainage work was undertaken during the year, the newly opened area being divided into 1) acre blocks by suitable drains. A new boundary drain was dug on the western boundary of Serdang Estate, with an outlet into the drain adjoining the side of the new entrance road. Further drains have been cut in this area to relieve the pressure of water in the drain on the eastern boundary of the plantation.

The following new buildings were erected on the plantation during the year:—

1 Set Cooly Lines 20 rooms.
2 Single Garages for Bungalows No. 1 and 2.
2 Cooly Line kitchens.
1 Cooly Line latrine.
1 Implement Shed.
1 Manure Shed
1 Quarter for Conductor.
1 Quarter for Watchman.
1 Seed Store.
1 Cement Drying Ground.

All existing buildings have been maintained in good repair.

The levelling of the Factory site was continued as opportunity occurred.

The labour during the year was mainly non-resident Chinese coolies engaged locally. These were supplemented with Tamils recruited from the coast. The Indian labour force was increased from 57 at the close of 1923 to 193 at the end of the year. The average number of coolies employed daily during the year was 870.

The health of the coolies living on the plantation was fairly good. The weekly oiling of all drains, which was commenced in October 1923, has resulted in there being few cases of malaria fever.

Insect pests have been very troublesome with almost all the crops. A pest gang was employed constantly in the collecting of insects by hand or spraying. The Insectary Assistant to the Entomologist, was stationed at the plantation from May 1st and was employed in pest work until he went on leave in September.

Crown disease of oil palms was prevalent during the year, but no permanent damage so far appears to result from this disease.

The average maximum temperature recorded during the year was 90.5°F. and the average minimum temperature 70.2°F., the highest maximum being 97°F and the lowest minimum 64°F.

Rain fell on 211 days during the year, giving a total rainfall of 92.37 inches as against 81.94 inches in 1923.

Records were taken of the wind velocity on the plantation by means of a cup-indicating anemometer.

A large number of visitors were shown round the plantation during the year. H. H. The Sultan of Selangor and staff, and about 60 Malays visited the plantation in January. The Incorporated Society of Planters paid a visit on July 14th when 29 members signed the visitors book. The Advisory Committee of the Department held a meeting on the plantation in December.

ANNUAL REPORT OF THE ECONOMIC DIVISION 1924.

By D. H. Grist.

THE name of this Division was changed in December of this year, the Instruction Division becoming the Economic Division. With this re-organization Capt. Howlett leaves the Division and becomes Agricultural Instructor (Malay Officers) being placed in charge of the training of the Malay Officers of the Department, and the Field Division undertaking the duties of the organization of school garden work—duties that were performed by this Division for the greater part of the year and therefore included in this report.

The duties of the Economic Division are as follows:—

(*a*) The economics and marketing of agricultural products, especially produce of small holdings.

(*b*) Liaison with the Co-operative Societies Department. Encouragement of the co-operative movement among native agriculturists.

(*c*) Conferences of Malay Officers and Agricultural Shows, excluding organization of District Shows (Assistance to be given to the latter on request, but no part would be taken in administration of District Shows).

(*d*) Publication of the Malay Bulletin and educative pamphlets in Malay on questions concerned with agricultural economics and marketing.

Staff.

The Agricultural Instructor (Mr. D. H. Grist) was on leave from March 14th till December 5th, during which period Captain J. M. Howlett, Agricultural Instructor, was transferred from Kuala Kangsar to act in his absence. On the return of Mr. Grist, Captain Howlett left the Division to take up his new duties.

Raja Mohamed, Senior Agricultural Assistant, was transferred to Teluk Anson, Perak, at the beginning of April to carry out special duties in connection with a kapok buying scheme.

Sheikh Hamzah, Malay Translator to the Department was attached to the Division on 1.2.24, and has carried out translation and general clerical work during the year.

Kapok Buying Scheme.

The Division secured Government approval in February of a scheme for organising kapok purchase on the Perak river. Cash advances were to be given to Malay Kapok growers for uncleaned kapok ;

the Division undertook the cleaning of the kapok and marketing of the floss, and profit to be distributed as a dividend. A collecting station was opened at Teluk Anson in charge of the Senior Agricultural Assistant. A sum of $1000 was allocated as working capital.

From the point of view of amount of kapok purchased (a little over twenty piculs) the scheme was not a success. Competition with Chinese buyers was largely responsible for the result, although the scheme had the salutary effect of making the Chinese raise their price from $5/- per picul to $12 per picul.

A hand kapok cleaning machine, on the design of the Bley machine used in Java was constructed, and proved suitable. It was found possible to clean kapok down to 2% of impurities with this machine.

PUBLICATIONS.

The Malay Bulletin of this Department (Warta Perusaha-an Tanah) was edited by the Division, and three parts of the second volume published during the year. The articles contained in these numbers were as follows:—

Vol. II No. 1. School Gardening.

No. 2. Maize
School Gardening.
Prevention of insect attack on fruit trees.

No. 3. Rat destruction
Insect attack on coconut palms
Money spent by Malays on daily purchase of vegetables.
Mouldy rot disease of rubber.

The distribution of this publication is carried out by the Division. 3000 copies of each issue are circulated to all responsible Malays throughout the Peninsula, and to all schools, and the list revised from time to time.

Malays from all parts of the country, and especially from the Unfederated Malay States, have shewn their interest in this Bulletin. Several articles written by Malays have been submitted for publication, and one.—"Money spent by Malays on daily purchase of vegetables," a somewhat remarkable and thoughtful article, was published. In addition, a number of letters on agricultural matters have been received. Thirty six Malays made written application for a total of 311 copies of the various Malay pamphlets published by the Department.

"Pengasoh" a Malay newspaper published in Kelantan, contained a lengthy article on the work of the Department, and its Malay publications, and later in the year a further article advocating a Department of Agriculture in Kelantan.

Agricultural Shows and Exhibitions.

Public interest in agricultural shows and exhibitions in Malaya has been sustained —encouraged by the Malayan Agri-Horticultural Association, with which the Division has kept in close touch. The Association organised a very successful three days show and exhibition in Kuala Lumpur, and ten district agricultural shows were held under the auspices of the Association. The Acting Agricultural Instructor was Hon. Secretary of the Agricultural Section of the Association, and assisted in organising and judging at several of the District Shows.

The Division staged a Departmental exhibit of fibres, diseases of rubber, alcohol production, rubber oil and miscellaneous crops at the Kuala Lumpur Show. A modification of this exhibit was subsequently shewn at various District Shows.

Conference of Malay Officers of the Department of Agriculture.

The Annual Conference of the Malay Officers of the Department was held on November 18th to 20th at Kuala Lumpur. The Hon'ble the Chief Secretary (Sir George Maxwell, K.B.E., C.M G.) delivered an opening address. Papers were read in English as under, each being followed by a short discussion.

"The duties of Malay Agricultural Officers" by Mr. F. W. South.

"Insects and Human Welfare" by Mr. B. A. R. Gater.

"The Principles of Stock and Poultry Breeding" by Mr. J. M. Howlett.

"The Formation of Local Phosphates and their application" by Mr. V. R. Greenstreet.

The following papers were read in the Malay language:—

"Miseltoes in relation to cultivated trees" by Inche Mohamed Zain.

"The practical distribution of improved strains of padi" by Inche Din.

"Methods of study of insect pests" by Inche Mohamed Yusope.

A visit was made to the Serdang Experimental Plantation.

Lectures.

The Acting Agriculture Instructor delivered lectures as under:—

Teluk Anson March 29th on "The objects of the Malayan "Agri-Horticultural Association."

Sitiawan June 15th on "Fibres."

School Gardens.

School garden work has become more popular amongst teachers throughout the country. They have been assisted by the periodical inspections made by officers of this Division, by articles on the subject published in the Malay Bulletin, and the supply of planting material.

Sites and schools gardens in Penang and Province Wellesley were visited by the Acting Agricultural Instructor, and advice given on such questions as rotations. A similar visit was made to Malacca, where thirty schools were visited, and a report made in connection with two sites. The condition and general garden work in Malacca schools were most encouraging.

The schools in Perak competed for gardening prizes offered by the Hon'ble British Resident, Perak, which has undoubtedly stimulated school garden work in the State.

Malay Officers Training.

Two courses of lectures by various of the scientific officers of the Department were held during the year. A course of lectures, Part I was commenced in February : twelve Malay officers took the course of whom eleven passed the terminal examination. A course of lectures, Part II, commenced on September 29th., thirteen Malay Officers taking the course. The course had not terminated by the end of the year.

An examination of Junior Agricultural Assistants to qualify for promotion to Senior Agricultural Assistants was held in July, seven officers sat, of which number, four passed.

An examination of Probationers to qualify for promotion to the grade of Junior Agricultural Assistants was held in July. Of five officers sitting for this examination, four passed.

The writer proposed a scheme for commencing a School of Agriculture near the Experimental Plantation, Serdang. The scheme was not approved on account of cost.

The work of training officers throughout the year has been in the hands of the Division, assisted by lecture courses by six scientific officers of the Department. In the time at the disposal of these officers, and also of the Malay Officers taking the courses, the standard of proficiency attained by the Malay Officers was not high. This was reflected in the examination work of the students. In consequence of the unsatisfactory nature of these and former results, and also to the fact that the proposed School of Agriculture did not receive Government sanction, the Acting Agricultural Instructor and the Chief Agricultural Inspector drew up a scheme of Malay Officers training, under the Agricultural Instructor. This allows for the full time of each new Malay Officer being devoted to study for a period of two years of three terms in each year. The lectures, with practical work will be given at the Department of Agriculture, Kuala Lumpur,

by the Agricultural Instructor and Raja Mahmud (Assistant Agricultural Instructor). This scheme was approved and commenced operation from December 15th.

MISCELLANEOUS.

As indicating the large number of enquires received by the Division on the cultivation and marketing of various crops, the following subjects were dealt with in correspondence during the period under review:—Indigo, kapok, tobacco, rubber seed oil, sago palm, coir preparation, bee-keeping, seaweed, and roselle.

In conjunction with the Forest Department, an article on Malayan damar as a "cottage industry" was prepared for publication in the Malay Bulletin.

Towards the end of the year, an investigation of the marketing possibilities of tuba (Derris elliptica) was put in hand.

ANNUAL REPORT OF THE PLANT PHYSIOLOGIST FOR 1924.

By W. N. C. Belgrave.

The Staff of the Division remained unchanged and consisted of :—

Mr. W. N. C. Belgrave.

Inche Haji Abdul Wahid.

Inche Jalaludin.

Work was almost entirely on Hevea latex, and was mainly directed to :—

(*a*) Chemical and physical phenomena connected with coagulation.

(*b*) The proteins and allied substances.

None of this work has reached finality, and a detailed account must be deferred until publication can be undertaken. It suffices to state here that considerable time has been devoted to De Vries' recent theory that coagulation following on separation is, or may be, brought about by an enzyme in latex. The writer has been unable to satisfy himself that the theory can be regarded as proved.

Tapping experiments involving the girdling of the trees under observation have continued and have not resulted in any apparent damage.

Additional Duties.

The writer acted throughout the year as Assistant to Secretary for Agriculture, and was in charge of the Library and of the publications of the Department.

It is hoped shortly to issue a much needed catalogue of the Library ; in this compilation the services of Mr. L. A. J. Rijk have been of great value.

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; and the Malay States Information Agency, 88, Cannon Street, E C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV	(1913-16) VIII & IX (1920-21)		price	$5.00 per volume.
Vol. V	(1917)	Nos. 1, 2, 3, 5 & 6	„	2.50 per set.
„ VI	(1918)	„ 1, 7, 8 & 12	„	2.00 „
„ VII	(1919)	„ 2—6	„	4.50 „

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

Vol. X (1922)	Price $5.00 per volume.
„ XI (1923)	Price $5.00 per volume or 50 cents per single number.
„ XII (1924)	„ „ „ „

Back numbers of Vols. I—X will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased at the Railway Bookstalls and Branches of Messrs The Federal Rubber Stamp Co.

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, Government Entomologist, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher. **C**
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, Government Entomologist, 1910, reprint 1916, 20 cts. (Out of Print.)
4. A Lepidopterous Pest of Coconuts, *Brachartona catoxantha, Hamps*, by H. C. Pratt, 1909. **C**
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909. **C**
6. Preliminary note on a Branch and Stem Disease of *Hevea Brasilienisis*, by W. J. Gallagher, 1909. **C**
7. Coffea Robusta, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910. **C**
9. Die-Back Fungus of Para Rubber and of Cacao, by K. Bancroft, 1911. **C**
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher, 1910. **C**
11. Coconut Cultivation, by L. C. Brown, 1911. **C**
12. Padi Cultivation in Krian, by H. C. Pratt, 1911. **C**
13. A Root Disease of Para Rubber, *Fomes Semitostus*, by K. Bancroft, Assistant Mycologist 1912, 20 cts.

C = Cancelled

THE

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INSECTS ON AFRICAN OIL-PALMS.

By B. A. R. Gater.

SEVERAL enquiries have been received regarding the possibilities of damage to African oil-palms (*Elaeis guineensis*, Jacq.) by insects, and it is considered that although investigations on the insects affecting this crop are only in the preliminary stages, a few notes on the subject would be of interest to planters. This article must be regarded purely as a progress report, and in no way as a comprehensive statement on matters which require to be much more fully investigated before definite conclusions can be arrived at.

In general it may be stated that the pests of oil-palms are much the same as those of coconuts, and some authors, in discussing the pests of various crops, collect all the pests of palms grown for ornament or profit under one heading. In addition to coconut pests which have been found attacking the oil-palm there are, however, several which have been found only on the latter, which, owing to differences in the two palms, may have a special significance from the economic point of view.

It is proposed here to deal with the insects concerned under three headings, covering those reported from other countries where oil-palms are grown, those recorded in Malaya, and a few words about the insect visitors to the flowers. The first class is especially important in the case of a comparatively new crop, owing to the danger of the accidental introduction of insects which are known to be injurious in other countries. In the case of one insect (*Pachymerus nucleorum*) which damages the nut in British Guiana, Dr. Leefmans records that out of a parcel of twenty-five seeds of *Attalea* palms received in Java twenty-four were attacked, and he immediately issued a warning to planters of the danger of introducing an insect of this type. The seeds, moreover, appeared to be quite sound externally, emphasising the ease with which injurious insects can be imported unless the material is submitted to expert examination. In discussing the pests of a particular crop, therefore, one of the first essentials is to obtain as accurate information as possible about the existing pests elsewhere which, if imported, would be capable of causing the most serious damage.

PESTS IN OTHER COUNTRIES.

Apart from coconut pests such as Rhinoceros beetles (*Oryctes* spp.) and Palm weevils (*Rhynchophorus* spp.) which have been recorded as attacking oil-palms wherever they are grown, the particular species of these insects varying with the country, there appear to be two insects of outstanding importance, one of which attacks the nuts and has been mentioned above, the other attacking the leaves.

Pachymerus nucleorum, F. (Bruchidae) The adult beetle is about a centimetre in length, stout in appearance and greyish brown in colour. The head is bent down and is situated on a distinct, rounded "neck" and bears rather long antennae.* According to Bondar the adult is nocturnal with a total life of about a month. Eggs are laid at the base of the nut, fifteen to twenty being produced by one female. The grub, which is curved, legless, and about a centimetre and a half in length when full-grown, bores into the nut through the sap-channels and feeds for two and a half months. The pupal stage is three weeks, but the newly emerged beetle remains within the nut for another week before making its way to the exterior.

Nuts are said not to be attacked while on the palms unless the latter are sickly or injured, but fallen nuts are always infested, to the extent, sometimes, of 70%. Supplies for one factory mentioned by Bondar were infested to the extent of 33%. In addition to the African oil-palm this insect has also been found in the seeds of the following palms:—*Bactris major*, Jacq. *Maximiliana regia*, Mart., *Attalea cohune*, Mart and *A. spectabilis*, Mart. It has been reported on oil-palms in British Guiana and Brazil.

Coelaemenodera elaeidis, Maulik. (Hispinae) The grubs of this beetle attack the foliage of oil-palms in the Gold Coast, probably in much the same way as *Promecotheca cumingi* attacks coconut leaves in this country. The Government Entomologist in the Gold Coast (W. H. Patterson) in his report for 1919 states:—"It has been reported that on one large concession the trees had fully 50% of their foliage destroyed: and that . . . . thousands of trees were without green leaves. Whilst some crop was obtained, there was a marked decrease in the size of the bunches and individual fruits, which had a thinner pericarp and therefore less oil".

The beetle is a typical hispid and is between four and six millimetres in length. It is pale yellow in colour, the wing cases being reddish except on the basal and apical areas. The grub is creamy white and measures about five millimetres in length when fully grown; the prothoracic segment being considerably expanded laterally, with the expansions rounded (S. Maulik, Bull. Ento. Res. x p. 171.)

Apart from these two, no serious attacks by insects other than *Oryctes* and *Rhynchophorus* have been recorded, as far as can be

* The rough description given is from Dr. Leefmans' description in Meded: Lab, v. Plantenziekten No. 37, which is of *Pachymerus* sp. probably *nucleorum*. I have no description of *P. nucleorum*, F.

ascertained from the literature available. Two scale insects (Coccidae) which occur in this country have, however, been recorded on oil-palms in the Seychelles, *Aspidiotus destructor*, Sign. and *Ischnaspis filiformis*, Dougl. The former is the cause of the extensive yellowing of coconut leaves seen on some coconut estates here, while the latter, although not so far reported to have done much damage in Malaya, was imported into the Seychelles and the oil-palm plantations became badly infested within a few years.

In the Dutch East Indies a number of pests of more or less importance has been reported from time to time A small scolytid beetle, *Xyleborus morstatti*, Hgd. bores into the ribs of the leaves, while caterpillars of the pyralid moth, *Mucialla ruforenalis*, Sn., attack the flowers and young fruits of oil-palm as well as coconut. The maggots of certain flies have been recorded as damaging the unopened leaves. Among leaf-eating insects the caterpillars of the nymphalid butterflies *Discophora celinde*, Stoll. and *Hypolimnas misippus*, L., of the limacodid moth *Orthocraspeda trima*, Moore, and of the psychid moth *Lansdownia bifenestralis*, Snell., may be mentioned.

INSECTS RECORDED IN MALAYA.

RHINOCEROS BEETLE (*Oryctes rhinoceros*, L.) This is the same insect which attacks coconuts and is too well known by planters to require description. On oil-palm estates attention should be paid to the masses of refuse from the factory, which form likely breeding places on the estate itself.

RED-STRIPE WEEVIL (*Rhynchophorus schach*, Oliv.) Another well-known coconut pest which also attacks oil-palms. It would be well to remember that it has been shown that the female will not lay eggs in undamaged palm tissues, and that if eggs are laid in cut petioles the grubs can bore their way down into the stem, instances having been observed where grubs went through thirty-six inches of petiole into the stem. (G. H. Corbett, Bull. 36· Dept: Agric: F. M. S.). One of the main methods of controlling this insect is to keep down the Rhinoceros beetle, whose borings in the crown are utilised by the Red-stripe weevil. This insect appears to prefer sago and "Nibong" (*Oncosperma tigillaria*, Hort.) to other palms for breeding purposes.

The above insects are serious pests, and as great care should be taken to prevent them spreading on oil-palm as on coconut estates, special attention being paid to the ends of petioles when the palms are pruned to prevent the entry of the Red-stripe weevil.

OTHER INSECTS. Among other pests recorded on this crop two appear likely to cause serious injury to the leaves locally, considerable damage being done on coconuts, especially young palms, when outbreaks occur. These are the Nettle caterpillar, *Setora nitens*, Wlk. and the Coconut caseworm, *Mahasena* sp. Both may be found in small numbers on both oil and coconut palms, but they occasionally escape from the control exerted by their parasites and increase to large numbers. This generally occurs on young palms, but they can be controlled by a lead

arsenate spray. Other insects found damaging the leaves are the caterpillars of the nymphalid butterfly, *Amathusia phidippus*, L. and the melolonthid beetle, *Anomala dorsalis*, F., both of minor importance. The aphid, *Oregma nipae*, de Goot, has been found on the leaves sucking the plant juices, but is also of minor importance at present. A lucanid beetle has been reported to damage the leaves, but this has not been confirmed, and dipterous larvae have been found in unopened leaves. Whether the latter are primary or whether they are associated with a fungoid disease is as yet uncertain.

At the end of last year the caterpillars of an as yet undetermined lymantriid were found gnawing the female flowers and young nuts, and in a few instances were observed, in the laboratory, partially to penetrate the flowers. The insects failed to breed in captivity but a female laid fifty-three infertile eggs. The pupal period was 4 to 6 days. The male appears to be similar to the description of *Orgyia turbata*, Btlr. but is smaller, having a wing expanse of 12 m/m only. The female is wingless, brown in colour with a whitish anal tuft; length (spirit specimen) 7 m/m. The caterpillar is brown with two long tufts of spatulate hairs directed forward from the 1st. segment, a tuft of spatulate hairs on the 11th, and four small tufts of plumescent hairs on the 12th; small lateral tufts along the body and short thick brushes of yellow hairs on segments 4 to 7. Short tufts of spatulate hairs arise from the centre of the dorsal tuft on 4 and sometimes on 5 as well; length 9 m/m.

It is unknown to what extent this insect may develop as a pest of oil-palm fruits, but the damage done to the cluster on which the caterpillars were found was considerable. It does not appear to be very widely distributed, having been found in one locality only, but a watch should be kept for it on other estates.

In addition to the above the larvae of a tineid moth were found in large numbers in the male flowers. The pollen had, however, already been shed and for the present it is concluded that this insect is a refuse-feeder and not a pest.

Status of Recorded Pests.

Although the list of insects which have been found damaging the oil-palm in Malaya comprises eight species, including four species which seriously attack coconuts, none has so far caused any serious damage on oil-palm estates in this country. The list of insect pests in West Africa is a small one, and nowhere does the crop appear to have suffered from the attacks of insects in a way comparable to coconuts.

As pointed out by Dr. Rutgers*, however, the oil-palm in West Africa, being scattered among other plants, grows under vastly different conditions to the planted areas in Sumatra and Malaya. This

* "Investigations on Oil-palms" published by the Experimental Station A. V. R. O. S. Medan, 1922, Chapter 7.

produces a more favourable set of conditions for the palms from the point of view of insect attack, and there is no doubt that under plantation conditions they will suffer more than in their natural habitat. The list of injurious insects in Sumatra has already exceeded that in the oil-palm belt in West Africa, although the first planted areas in Sumatra only date back to 1911.

At present it appears that the insects attacking both palms have a preference for the coconut, and this is probably the reason why the Rhinoceros beetle and the Red stripe weevil have not harmed oil-palms in Malaya to any extent. Dr. Rutgers (*ibid*) mentions a case where the Rhinoceros beetle attacked some oil-palms in Sumatra, doing comparatively little damage, but a block of coconuts 200 metres distant was so severely damaged that several died as a result of the attack.

For the moment then, it may be stated that no serious damage by insects occurs on this crop, but the fact that insects dangerous to coconuts have been found injuring the oil-palm emphasises the necessity for keeping a careful watch for pests on all estates.

Two possible sources of danger should be considered ;—

1. The adaption of local insects, especially those which damage coconuts, to the oil-palm.
2. The importation of insects likely to attack oil-palms.

Of these the first has been shortly discussed above, but the danger from the second source cannot be over estimated. The worst pests in any country are the result of imported insects, and great caution is therefore required in bringing seeds or other portions of the oil-palm into Malaya. It should never, in fact, be done without the co-operation of some competent authority, and even then it sometimes happens that insects, escaping all preventive and precautionary measures, obtain an entry and establish themselves as pests of the first magnitude in a new country.

Pollination.

The question of the pollination of the oil-palm by insects has been raised owing to the necessity of hand pollinating the flowers. Hand pollination is the practice followed on estates during the early stages of the palm's growth, but according to planters with extensive experience of oil-palms artificial pollination becomes unnecessary when the palms have reached a certain height, the palms being then sufficiently exposed to enable air currents to carry the pollen. Moreover, practical growers state that continued hand pollination, ensuring as it does the fertilisation of a large percentage of female flowers, is injurious to the palm, since too many fruits are set to enable the palm to retain its full vitality. On the other hand it has been shown that very poor yields are obtained where hand pollination is not done, and it is stated that for a proper return this operation is a necessity. The extent to which artificial pollination is necessary does not come within the scope of this article, but the fact that it has to be resorted

to, whether for a limited time or throughout the productive period of the palms, has led to enquiries as to whether or not the propagation of insects, such as bees, would relieve planters of the necessity of pollinating the flowers by artificial means.

In nature it is assumed that pollination is effected by wind and insects, and Bücher and Fickendey, writing of conditions obtaining in Africa, state that wind is the most important agent Chevalier has stated that pollination in Africa is brought about by a small weevil which is found on the male and female flowers, but it was found by Beccari that this weevil lays its eggs in the male and sometimes in the female flowers, the grubs subsequently destroying the buds. Rutgers states that in Sumatra a few bees have been seen collecting pollen.

The literature on the subject of the pollination of the oil-palm is so scanty that no idea can be formed as to whether or not pollination by insects is an important factor in the fruiting of oil-palms in nature. When a crop is introduced into a new country it is very frequently found that little or no fruit is formed owing to the absence, in the new country, of the particular insect which is responsible for carrying the pollen in the plant's natural habitat, and since in the case of the oil-palm there is no information on the subject as far as the writer has been able to ascertain, we are completely in the dark as to what occurs under natural conditions.

When a plant fails to set fruit in new surroundings it is possible, by a study of its insect visitors in its original home, to import the insect which is found to be the most useful vector. With regard to the weevil (*Derelomus*) mentioned by Chevalier it would, of course, be extremely dangerous to import it owing to its habit of destroying the flowers: no insect should be imported until the fullest investigation had been made into its intimate life-history. Even in the case of parasites on injurious insects, the introduction is accompanied by grave risks unless every possible detail is first examined, owing to the habit of some insects of not only parasitising an injurious insect, but of attacking at the same time other insects which are actually beneficial, thus nullifying the object of their introduction and sometimes even causing considerable harm by reducing other beneficial insects, thereby allowing injurious pests to increase. The introduction of any insect for beneficial purposes must be carefully examined from a critical point of view, and the necessary life-history studies can only be done on the spot.

In order to find out what influence, if any, insects had as vectors of oil-palm pollen in Malaya, nineteen flowering palms were kept under observation and daily collections made of the insects found on the male and female flowers. Over 1400 insects were collected in this manner, an interim statement of those collected up to the end of last year having been included in the annual report of the Entomological Laboratory for 1924. The fact that an insect visits a flower does not necessarily mean that it effects pollination, and the present results are of visits only. On the surface, however, it it is evident that they have little influence (at any rate for certain periods of the year)

on pollination owing to the fact that an overwhelming majority was taken on the male flowers, thus showing that although insects visit the oil-palm in considerable numbers they do not make an adequate return for what they take from the plant. The fact that only a few were found visiting the female flowers seems rather curious in view of the smell of anise which emanates from flowers of both sexes, and which would presumably be attractive to certain insects. In addition the visitors appear to vary somewhat with the time of year, doubtless due to an alteration in the abundance of other food. Various species of Dermaptera, mostly *Chelisoches morio*, *F.*, Coleoptera, Diptera and Hymenoptera were included in the collection, but so far as could be seen only the members of the family Apidae occurred with a regularity sufficient to be of any possible use as pollinators. The following table gives the number of members of this family caught on the male and female flowers :—

Insect.		Caught on :— ♂	♀	Percentage of Total No.
Apis florea	...	152	10	11.3
„ *indica*	...	212	7	15.6
„ *dorsata*	...	278	45	22.6
Melipona spp.	...	545	2	38.3
Other insects	...	175	—	12.2
Total	...	1,362	64 = 1,426	

The figures indicate that although several species of bees are frequent visitors to the oil-palm, their object is the collection of pollen rather than nectar. Little can be said on the subject of the relative frequency of visits by any one species, since this depends on the number of colonies in the locality; the same experiment repeated elsewhere would be certain to give different data. The principal point brought out is that it appears to be the pollen which is the attraction, and that out of 1426 insects only four and one half per cent. visited the female flowers. It will be seen that there is no scarcity of certain bees, so that any pollination which they perform will be effected naturally in this country, but proof is needed as to whether the visitors to the female flowers actually bring about fertilisation, and more observations are needed over a wide area before accurate data will be available.

Received for publication 2nd July 1925.

SOME OBSERVATIONS ON TAPPING OF HEVEA.

BY W. N. C. BELGRAVE.

FOUR years ago observations were started on a limited number of trees in different localities with a view to studying the behaviour of individuals to be used subsequently as material for physiological experiments. Some of the observations may be of general interest and are here described.

The experimental plots were :—

Plot A. —A plot of 50 trees, sixteen years old, on very gently sloping land at Castlefield Estate,* Selangor. There were 43 trees per acre when observation commenced. The tapping system was and had been for some time, a V cut on half the circumference tapped on alternate days.

Plot B.—A similar plot to A, at Castlefield on flat land. The trees on both plots A and B were remarkably healthy in appearance and bark renewal was excellent.

Plot C.—A plot of 75 untapped eight year old trees at Batu Tiga Experimental Plantation. The soil was a heavy, very acid clay, liable to frequent flooding, and the trees were stunted, with thin bark and sparse, unhealthy looking foliage.

Plot D.—A plot of 100 sixteen year old trees at the Experimental Plantation, Kuala Lumpur widely planted on steeply sloping land. The field has never been thinned.

Plots E. F & G.—Three adjacent plots of 60 trees each, grown under similar conditions, situated on both sides of a steeply sloping ravine. The trees are fifteen years old and have never been thinned-out, having purposely been allowed to become overcrowded. They are on the whole poorly developed, with hard, stony bark.

Plot H.—A plot of 1000 trees, 15.4 acres in extent, fourteen years old at Castlefield Estate, on nearly flat land.

TAPPING AND COLLECTION.

Except on plots A, B & H all cuts were started 30" above ground level. Tapping was carried out as part of the usual routine of the plantation and the particular days selected for record-making were never known beforehand to the tappers.

When determinations of dry rubber were made, the latex was rapidly coagulated in the cups by addition of a few ccs of a dilute solution of calcium chloride and acetic or hydrochloric acid—the resulting pads of rubber were marked and brought to the laboratory, creped in the usual manner, air-dried and weighed to the nearest gram.

*The writer desires to express his best thanks to Mr. D. S. Gardner, Manager of Castlefield Estate, for permission to make observations, and for help freely given on this as on many other occasions.

CONSTANCY OF YIELD.

For the first few months, observations on plots A, B, D & F, were made weekly, but it was soon found that intervals of a fortnight could safely be allowed—and these were subsequently extended to a month or more between collections. This was possible as, after the initial period of opening up and establishing latex flow had passed, the order of merit of the trees on any one plot was remarkably constant. Although the period of these observations is not nearly long enough to prove or disprove the oft-quoted dictum that "good yielders remain good yielders"—it is sufficiently long to confirm some recent views that for thinning-out, or selection, elaborate records are unnecessary For practical purpose, the rough method already in use on many Estates is sufficient—viz. an inspection made twice or three times a year (excluding the wintering season) and the trees marked A, B or C according as the cups show a yield above the average, or below average.

The well known effect of disease in influencing yield must, of course, be borne in mind in such observations.

INITIAL AND SUBSEQUENT YIELD.

Observations were made on plots C, D, E, F & G, on the extent to which yield on first opening may be used as an index to subsequent yield.

On plot C, which gave a poor yield throughout· no connection could be traced between initial and subsequent yields. On the other plots, the highest and lowest yielders gave marked indications of their capacities, but no differentiation between the majority of trees, the average yielders, could be made.

It should be understood that the trees observed were more than eight years old; it is not suggested that relatively high or low yielders can be picked out in this way on young areas, nor indeed is it suggested that the observation is of general application to older areas.

EFFECT OF EXPOSURE ON YIELD.

As it seemed not impossible that the temperature of the tissues below the tapping cut might influence yield, observations were made on plots A and B—where simultaneous change over was not in force—of the effect on yield of changes of tapping surfaces from the sides of the tree facing the morning sun to those not so exposed, and vice versa.

No changes which could be attributed to this factor have been noted.

REACTION OF LATEX.

Observations were made on plots A, C, F & G on the reaction of the latex as it flowed from the trees. On plots A & C litmus paper was used, and on F & G methyl red and diethyl red. Of all the trees, only four gave markedly acid latex, and were very poor yielders. On the other hand many equally poor yielders gave latex

of the average pH value, and no relationship between reaction and yield could be traced.

In many cases it was noted that the partly coagulated latex on tapping cuts at the end of the period of flow was markedly acid, while the latex in the cup was still nearly neutral. This naturally suggested the cessation of flow might be related to increased acidity, but experiments in which a faintly alkaline solution was kept running slowly along the cut gave no positive evidence of increased yield.

VISCOSITY.

Rough determinations of viscosity were made in the field with a pipette. No close relationship could be established but many poor yielders gave very viscous latex, often of high dry rubber content, while no very high yielder gave latex of high viscosity.

ACID-CONTAINING CELLS.

In 1923 attempts were made to relate the position of cells with strongly acid cell-sap (subsequently described by Bobilioff) vis à vis the latex vessels, and yield, as it seemed not impossible that the withdrawal of fluid on tapping might lead to excretion of acid into the vessels.

No relationship could be traced.

GIRTH.

Although the number of trees and plots is too small for far reaching conclusions to be drawn from the application of statistical methods, such an application is not without interest.

Applying the usual methods to plots A and F, both tapped on half the circumference alternate daily, the following figures are obtained :—

TABLE I.

	Plot A 46 trees and 21 collections.	Plot F. 60 trees 20 collections.
Mean yield in grams dry rubber -	31.7 ± 1.2	21.4 ± 1.1
Standard deviation of yield -	13.2 ± .9	11 6 ± .75
Coeffn. of variability of yield -	41.5	54.2
Mean girth in cms. at 30 cms above ground level -	187 ± 3.0	116 ± 2.6
Standard deviation of girth -	32.8 ± 2.3	28.2 ± 1.8
Coeffn. of variability of girth -	17.5	24.3
Coeffn. of correlation between yield and girth -	.39 ± .08	.55 ± .06

The careful and extensive work of Whitby[1] and La Rue[2], in the F.M.S. and Sumatra respectively gave lower figures for correlation viz :—

Whitby—1011 trees, seven years old 0.260 $\pm$ 0.020

La Rue—949 „ eight „ 0.299 $\pm$ 0.019

Both figures indicate a positive relationship, but one much too small to be, in itself, of practical value.

In view of these two studies it is surprising to find the idea gaining ground in the F.M.S. that yield is closely related to girth, and that girth might be used as a measure of yielding capacity. It is suggested that this view is based on two recent publications, one in the Bulletin of the Rubber Growers' Association,[3] giving a summary results of experimental tapping, the other the work of Bryce & Gadd in Bulletins of the Department of Agriculture Ceylon. (Nos. 55 and 68).

In the former, it is stated :—

" The correlation between the girth and number of latex vessel " rings is so close that for selection purposes the authors consider that " it is sufficient to take the girth measurement at 20 inches from the " ground."

In the latter (Bulletin No. 55 p.41) under Summary—there is "(12) Where selected seed is used, the character girth can be "used as a basis on which to select trees for thinning."

It is to be feared that not all readers realise that the implication of the R.G.A. workers that latex ring development may be used, alone, for selection is by no means proved, and in fact meets with dissent from those who have done most work on the subject e. g. La Rue (loc. cit 581) and Bryce & Gadd (loc cit Bull. No 68 p. 62).

The proviso of the second quotation is all important; the authors were recording yields from the seedling offspring of *one* female parent, obviously great caution is necessary in applying this result to mixed plantations. This need for caution was clearly stated by Bryce & Gadd, but appear to have been overlooked by some readers.

To revert to the R.G.A. summary, it is unfortunate that curves should have been used to represent the relationships investigated—as is well known (c.f. Bryce & Gadd Bull. No. 68 p 57) they are unsuited for this purpose—particularly when the values, taken as ordinates and abscissae are the means of group values, as opposed to individual figures. To make this point clearer the data from plots A and F may be arranged as follows:—

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1. Whitby—Variation in Hevea bras : Ann. of Bot. *33*, 313, 1919.
2. La Rue—Structure and yield in H.b. Arch. f.d. Rub. Cult. *5*, 574, 1921.
3. Tapping Experiments. Bull. R. G. A. *6*, 87, 1924.

TABLE II.

Plot A.

GIRTH IN CMS.

	100-120	121-140	141-160	161-180	181-200	201-220	221-240	241
Mean yield in grams of individual trees.	15	32	38	31	73	45	68	32
		27	30	29	52	44	58	31
		22	30	29	52	41	43	
			22	23	51	39	36	
			18	23	42	37	33	
			17	12	38	25		
			16		26	22		
					21	20		
					20	18		
					19	18		
					16			
Mean of each group.	15	27	24.4	26 5	35.4	30.9	45.6	31.5

Plot F.

GIRTH IN CMS.

	61-80	81-100	101-120	121-140	141-160	161-180	181-200
Mean yield in grs. of individual trees.	8	20	48	36	42	48	46
	7	18	40	33	29		24
		17	37	27	29		
	4	16	33	25	23		
		12	33	24	20		
		11	31	22	18		
		11	27	19			
		10	26	19			
		4	23	11			
		4	20				
			20				
			19				
			19				
			19				
			18				
			18				
			16				
			12				
			11				
			10				
Mean of group.	6 3	12.6	22.8	24	25.7	48	35

Excluding irregularities due to working with small numbers, both sets of figures, if plotted would give curves of the type of the R.G.A. publication, yet, inspection of the tables shows:—

Plot A.—If the eleven smallest trees were removed one good (38) and three fair yielders (32, 30, 30) would be taken and five poor yielders would be left; if the seven largest trees were selected as mother trees, three fair yielders (31, 32, 33) would be included and four high yielders (73, 52, 52, 51) would be omitted.

Plot F.—If the thirteen smallest trees were removed one average yielder (20) would be taken and five (10, 11, 11 12 and 16) poor yielders left; if the nine largest trees were selected, four fair yielders (18, 20, 23, 24) would be included and three high yielders omitted (48, 40 37).

Selection by girth could therefore hardly be regarded as satisfactory either for thinning or breeding. In view of the simplicity of the method of making rough classifications of the yielding capacity of trees and the ascertained approximate relative constancy of yield, there would appear to be little excuse for the absence of yield records from areas of tappable age.

On immature areas thinning has, up to the present, been conducted on appearance (which includes girth) and considerations of space, and no better alternative has yet presented itself.

So far as the writer knows it has not yet been shown that there is a close correlation between girth and latex-ring developing at say, 3 years and that at 5 years, La Rue (loc. cit p. 577) has in fact, brought forward indirect evidence to the contrary. Until such correlation has been shown to exist the usual method of thinning must be realised to be empirical (although necessary) and the selection of high yielders on immature areas by girth measurements to be hazardous.

YIELD, AN INHERENT CHARACTER?

Bryce and Gadd have studied the rates of change of girth latex ring development, bark thickness and yield from one year to the next. Their result are summarised as follows (Bull. No. 68 p.69.)

" The three characters—girth, cortex thickness, and number of
" latex vessel rows—are so interlinked that a change in one is ac-
" companied by a corresponding change in the others. Any increase
" in the rate of growth results in an increase in cortex thickness, num-
" ber of latex vessel rows, as well as in girth. Increase in the rate of

"growth does *not*, however, result in increased yield. Increase in
"yield must, therefore, be considered to be independant of the growth
"rate."

"GROWTH AND YIELD."

"It is not generally recognised that increase in yield is independent of increased growth and conversely that increased growth is not necessarily accompanied by increased yield. These facts are important in their bearing on estate practice in that methods of cultivation directed toward encouraging increase in growth do not necessarily result in increase in yield. Where increase in yield has occurred following such methods of cultivation, it must be considered as a direct effect of such treatment on yield, rather than an indirect effect through any increased growth that may be induced."

"Estate cultivation consists principally of working the soil and manuring, and the direct result of this treatment is increased growth. With regard to other crops, such as tea, coconuts, and cocoa increased growth thus induced results in bigger crops, but the nature of the crop is in these cases vastly different to the crop in the case of rubber. In the case of tea the crop is the leaf, and the more vigorous the more abundantly leaf is produced. In coconuts and cocoa the crop is the fruit which consists mainly of food materials manufactured by the leaves. The rubber crop, however, is derived from the latex, and though the function of the latex is still unknown, its value to the tree appears to be small, as the loss occasioned by tapping does not greatly diminish growth. There is then no apparent connection between latex production and growth.
"..

"It has been shown .. ..that those trees which during the course of these investigations have made the greatest percentage increases in girth are not in general the trees which have given the greatest percentage increases in yield, the coefficient of correlation for these characters being $+.03 \pm .054$. If increase in girth is regarded as a measure of growth activity, then increase in yield cannot be ascribed to the same cause."

"Of the many manurial experiments carried out on rubber no one experiment, to the knowledge of the writers, has indubitably proved that the application of manures has increased the yield of rubber That the application of manure increases the growth and general vigour of the trees is undoubted, as it is possible to distinguish manured from unmanured fields at a distance by their general appearance, manuring probably promotes also a more rapid regeneration of the renewing cortex, increase in cortex thickness being interlinked with increase in girth. Manuring therefore maintains the general vigour of the trees, but there is no evidence that it increases the yield."

"These observations lead to the conclusion that yield is independent of vegetative vigour. Yield is an inherent character; a tree is, in general, born a good yielder or a bad yielder, and no special cultivation or treatment will convert a poor yielder into a good yielder. It is possible, however, owing to disease or to unfavourable conditions that high yielders may become mediocre or even poor. Cultivation in estate practice should, therefore, be directed toward the maintenance of the trees in normal conditions of health and growth, to enable them to give the greatest yields that their inherent character renders possible."

Grantham's more recent publication* has supplied a case in which manuring *has* largely affected yield.

The writer cannot agree that a clear case for yield as predominantly an inherent character has been made out from the observations of the authors quoted. Irrespective of the function, if any, of latex, the all important point would appear to be that "yield" on tapping is an un-natural event and not a function of the tree at all, (a point stressed elsewhere by Bryce and Gadd) as it would be if the bark was destructively extracted for rubber. Actually, Bryce and Gadd have shown that growth results in a proportionate development of latex rings and therefore presumably of rubber *within* the bark. Yield, as an un-natural event, may be expected to be the result of the interplay of a number of factors, some inherent and others accidental.

The result of growth may well be to change some of these factors in a direction favourable to increased yield and others in an adverse direction. To give an example, it seems reasonable to suppose that the cessation of flow of latex is influenced by reduction of pressure in the tree brought about by excess of transpiration over absorption, in which case the flow may cease earlier or later as transpiration is more or less vigorous.† Now a rapid increase of girth may be connected with a rapid increase of leaf surface and vigorous transpiration but a relative lag in absorption, due either to a lag in root development, or more likely, to lack of immediately available water; given such conditions there may be early cessation of flow which may result in stationary yield but increased girth.

It should be clear that the question of the nature of yield is not merely an academic one. If environment early or current, can to an appreciable extent directly modify yield, then increases of yield by beneficial changes of environment should be a possibility on existing areas and the discovery of methods of bringing about such beneficial

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* Grantham Manuring Experiments on Hevea. Arch f. d. Rub Cult *8*, 501, 1924.

† c.f. Sharples, M.A.J. *12*, 315, 1924, who mentions observation that flow continues longer on damp mornings than on dry ones.

changes becomes a problem of even greater importance than it would be if the vigour of the trees alone was concerned.

Double V. Tapping.

Experiments with girdling cuts planned for the Brown Bast Investigation Committee and carried out on Castleton Estate* had shown little damage to the trees provided the interval between tappings was one day or more, while the yield obtained under such conditions was promising. It seemed worth while to continue experiments with long cuts and on plots C. D. E. G & H this was done. For convenience two opposite V-s, each over half the circumference, were used instead of the full spiral.

Plot C.—There were 50 trees tapped on one quarter daily, and 25 trees on a double V twice a week. After more than a year of tapping, yields were still so low that this plot was abandoned. Excluding the wintering period, the mean yield per tapping per tree from the daily tapped trees was 13 ccs., while that from the double V trees was 38 ccs. Taking the number of tappings per year as 350 daily and 100 twice weekly the yearly yield would be 455 ccs and 380 ccs. respectively, while the relative quantity of bark removed would be as 87 : 100 -assuming that the amount removed at each tapping was the same On this particular and very bad area comparison with alternate day tapping on a single V would probably be more favourable to the double V.

The renewal of bark on the double V trees was better than on the trees tapped daily.

Plot D.—This plot had rather a chequered career. The trees were all tapped for 8 months daily on the double V to establish a basis for comparison, then divided into two groups and tapped for 17 months on the double V once and twice weekly respectively. The two groups were then sub-divided, and alternate trees of the first group tapped weekly on one V and two V-s, while those of the second were tapped twice weekly on one or two V-s.

After 7 months the intervals were reduced and the groups tapped alternate daily and daily respectively for two months.

Renewal has been that normal to this field.

Results were as follows :—

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* Recorded by Sharples and Lambourne in this Journal XII Nos. 9 and 10 1924.

TABLE III.

Plot D.

Date	Field.	No. of Tapping System.	No. of Collections.	No. of Total yield in ccs.	Yield per task per field.	No. of trees in tapping.	Months in tapping.	Yield per tree per annum (calculated).	Bark* removal (calculated).	Yield per unit of bark removed per annum.
25-4-22 to 13-7-22	No. 1 to 50 -	Daily 2 Vs -	6	11,261	1,875	50	3	13,125	700	18.9
do. -	No 51 to 100 -	do. -	6	10,394	1,732	50	3	12,724		18.2
13-7-22 to 17-12-23	No. 1 to 50 -	2 Vs weekly -	31	84,959	2,740	50	17	2,740	100	27.4
do. -	No. 51 to 100 -	2 Vs twice weekly	31	65,324	2,107	50	17	4,214	200	21.1
17-12-23 to 22-7-23	No. 1 to 50 odd numbers.	Weekly 1 V -	13	10,518	809	25	7	1,618	50	32.5
do. -	do. even numbers -	Weekly 2 Vs -	13	20,228	1,556	25	7	3,112	100	31.1
do. -	No. 51 to 100 odd -	Twice weekly 1 V -	13	7,428	571	25	7	2,284	100	22.8
do. -	do. even -	Twice weekly 2 Vs.	13	17,233	1,325	25	7	5,300	200	26.0
22-7-24 to 29-9-24	No. 1 to 50 (odd) -	Alternate day 1 V	5	5,481	1,096	25	2	7,884	180	43.8
do. -	do. (even) -	Alt. day 2 Vs. -	5	10,330	2,066	25	2	14,875	360	41.3
do. -	No. 51 to 100 (odd)	Daily 1 V -	5	5,475	1,095	25	2	15,330	350	43 8
do -	do. (even) -	Daily 2 Vs. -	5	10,078	2,015	25	2	28,210	700	40.3

*The 'unit' is taken as the amount removed by tapping once on one V.
Daily tapping as 350 times per annum.
Alternate day 180 ,, ,,
Twice weekly 100 ,, ,,
Weekly 50 ,, ,,
In the case of weekly tapping, the actual amount of bark removed is greater than the calculated.

Plot E.—This plot was tapped for nineteen months twice a week on the double V—half the trees were then tapped on one V only while the remainder were continued on the double V, both groups being tapped twice weekly. As on plot F owing to the poor quantity bark and poor yield, bark consumption was high. Renewal has been the same as on Plot F i. e. fair.

Results of dry rubber determinations are :—

(See Table IV on following page.)

Again it is clear that the long cut has had no special effect. The close approximation of the mean yield per unit of bark removed to that for plot F. (21.49 grs.) tapped alternate daily is noteworthy.

Plot G.—This plot was tapped daily on the Double V for twelve months in an attempt to provide material for the study of incipient brown bast. Unfortunately only one case developed.

The yields of latex and dry rubber were at first similar to those of plots E & F—allowing for bark removed but the concentration of rubber rapidly fell from 35--38% to 19-21% while the volume of latex remained steady. The renewing bark after 10 months showed a number of small burrs which are developing with signs of Brown Bast in the surrounding tissues.

Plot H.—This plot was divided into 5 groups of 200 trees, each group being tapped once every 5 days. The latex was bulked and treated in the usual estate routine.

Results are given in table V.

(See Table V on following page.)

Bark renewal is remarkably good, and the trees have not suffered from bark affections. It will be noted that additional help had to be given to the tapper to enable the latex to be brought to the factory at the usual time.

Bark consumption as may be seen was high, (at the rate of approximately ½ inch per month) due to drying out of the bark between tappings. If drying out is neglected and bark consumption taken at 4/5 that of alternate day single V, the results from plots D and E would give an expectation of 4/5 the yield from alternate day single V—actually, the yield on the latter system from the yield is given at 425—450 lbs. of 1st latex rubber, and the result for September-December 1923 shows that the yield from alternate day tapping is certainly not greater than that from the double V.

This suggests that the longer cut has here had a physiological effect just as it appeared to have on Castleton. Increased duration of flow is a marked characteristic of this plot.

TABLE IV.

Plot A.

Tree No.	Mean of 11 collections 2 spouts.		Mean of 13 collections 2 spouts.	1 spout.
1 ...	71			29
2 ...		181	125	
3 ...	61			31
4 ...		16	10	
5 ..	41			26
6 ...		29	25	
7 ...		108	101	
8 ...	87			28
9 ...		33	43	
10 ...	66			38
11 ...		18	18	
12 ...	53			29
13 ...		101	116	
14 ...	50			22
15 ...		45	43	
16 ...	125			73
17 ...		86	66	
18 ...	17			17
19 ..		35	29	
20 ...	105			94
21 ...		18	14	
22 ..	36			17
23 ...		30	28	
24 ...	18			7
25 ..		11	19	
26 ...	37			21
27 ...		24	14	
28 ...	18			18
29 ...		52	53	
30 ...	29			14
31 ..		73	87	
32 ..	31			13
33 ...		13	12	
34 ...	108			46
35 ..		19	14	
36 ..	30			17
37 ...		31	31	
38 ...	37			10
39 ...		21	11	
40 ...	45			23
41 ...		96	108	
42 ..	63			29
43 ...		33	34	
44 ...	27			13
45 ..		32	31	
46 .	28			16
47 ...		33	29	
48 ...	50			29
49 ...		55	102	
50 ...	32			13
51 ...		45	40	
52 ...	13			9
53 ...		43	37	
54 ...	58			22
55 ...		23	23	
56 ...	58			16
57 ...		12	13	
58 ...	23			14
59 ...		15	13	
60 ...	10			6
	1417	1331	1289	740
Mean yield per tree	47.2	44.3	42.9	24.6

TABLE V.

Plot H.

Month.	Year.	No. of tap-ping days.	No. 1 latex dry weight lbs.	Yield per tap-ping lbs.	Remarks.
April -	1922	15	5	3.5	One cooly only.
May -	,,	30	333	11.1	do.
June -	,,	30	433	14.4	do.
July -	,,	30	482	16.0	do.
August -	,,	30	525	17.5	do.
September -	,,	30	558	16.6	do.
October -	,,	27	472	17.5	do.
November -	,,	24	458	19.2	do.
December -	,,	23	448	19.0	do.
January -	1923	26	457	17.6	do.
February -	,,	23	370	16.1	do.
March -	,,	26	365	14.0	do.
April -	,,	24	339	14.1	do.
May -	,,	21	307	14.6	do.
June -	,,	25	39[illegible]	15.6	do.
July -	,,	30	420	14.0	do.
August -	,,	22	324	14.7	do.
September -	,,	23	291	12.6	Ordinary tapping round. Experiment Stopped.
October -	,,	26	345	13.2	do.
November -	,,	24	341	14.2	do.
December -	,,	26	420	16.1	do.
January -	1924	28	812	29.0	Experiment contd. 1 extra cooly to collect.
February -	,,	27	750	27.7	do.
March -	,,	29	580	20.0	do
April -	,,	24	492	20.5	do.
May -	,,	29	621	21.4	do.
June -	,,	28	598	21.3	do.
July -	,,	30	700	23.3	do.
August -	,,	26	551	21.2	do.
September -	,,	27	601	22.2	do.
October -	,,	27	658	24.4	do.
November -	,,	27	655	24.3	do.
December -	,,	29	733	25.2	do.
January -	1925	27	740	27.4	On Jany. 1st 10" tapping surface remaining, 18" having been removed
February -	,,	23	574	24.9	do.
March -	,,	31	728	23.5	Wintering heavily.
April -	,,	29	677	23.3	do.
May -	,,	27	755	27.9	do.
Total yield from 2 Vs -			11,225		
Mean yield per acre per annum -			506		

Other Plots.—Two similar plots were started on other estates, one on 9 year old rubber on flat land gave yields equal to the average of field after a month's tapping and maintained these yields for 6 months.

The other on 5—6 year old rubber on flat land gave very low yields, and the experiment was stopped.

Discussion.—The results given above suggest that there is no commercial future for tapping methods involving long cuts and long intervals; even if there is a compensating increase of flow, drying out leads to too rapid consumption of bark relative to latex obtained.

From the theoretical view point, however, there are indications, but no more than indications, that may be of some importance. Summarised we find that plots D & F on hilly, somewhat washed land gave yields roughly proportional to the length of cut and frequency of tapping—while the yields on Plot H, Castleton, and another estate, all on flat land, strongly the suggested yields under this system were greater than the theoretical.

This would seem, in the first instance, to point to water-supply as a limiting factor in production; if this can be confirmed by work on these, and other lines, many puzzling problems might be solved, while it is needless to stress the practical results that might follow.

SUMMARY.

The possible connection between a number of factors and yield is discussed

The question of yield as an inherent or individual character is discussed.

The results of tapping at long intervals with long cuts are given.

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CALOPOGONIUM MUCUNOIDES.

By J. N. Milsum and E. A. Curtler.

IN Circular No. 4/24 "Cover Plants in Malaya," published by the Department of Agriculture, reference was made to this comparatively new cover plant, and the following notes are written in view of the interest shown in this introduction.

Calopogonium Mucunoides, Desv. is a native of tropical America but has become established on the East Coast of Sumatra and in parts of Java. Its vigorous growth amongst 'lalang' being noticed in Sumatra, a trial was made in 1922 to ascertain its value as a cover crop in young rubber areas in that country (1). Since its employment as a cover plant, Calopogonium has become very popular on estates in Sumatra and has been planted to a less extent in this country. In this connection it is of interest to note that at least two other herbaceous plants indigenous to tropical America have now become widely distributed in the Malay Peninsula, these being the the Sensitive plant, *Mimosa pudica*, and the wild Passion flower, *Passiflora foetida.*

Seed was obtained from Sumatra in September, 1924, by the Department of Agriculture and the observations recorded are based on experience with this plant during a comparatively short period only. Several estates, employing this cover, have been visited and the opportunity taken of observing it, where planted over large areas.

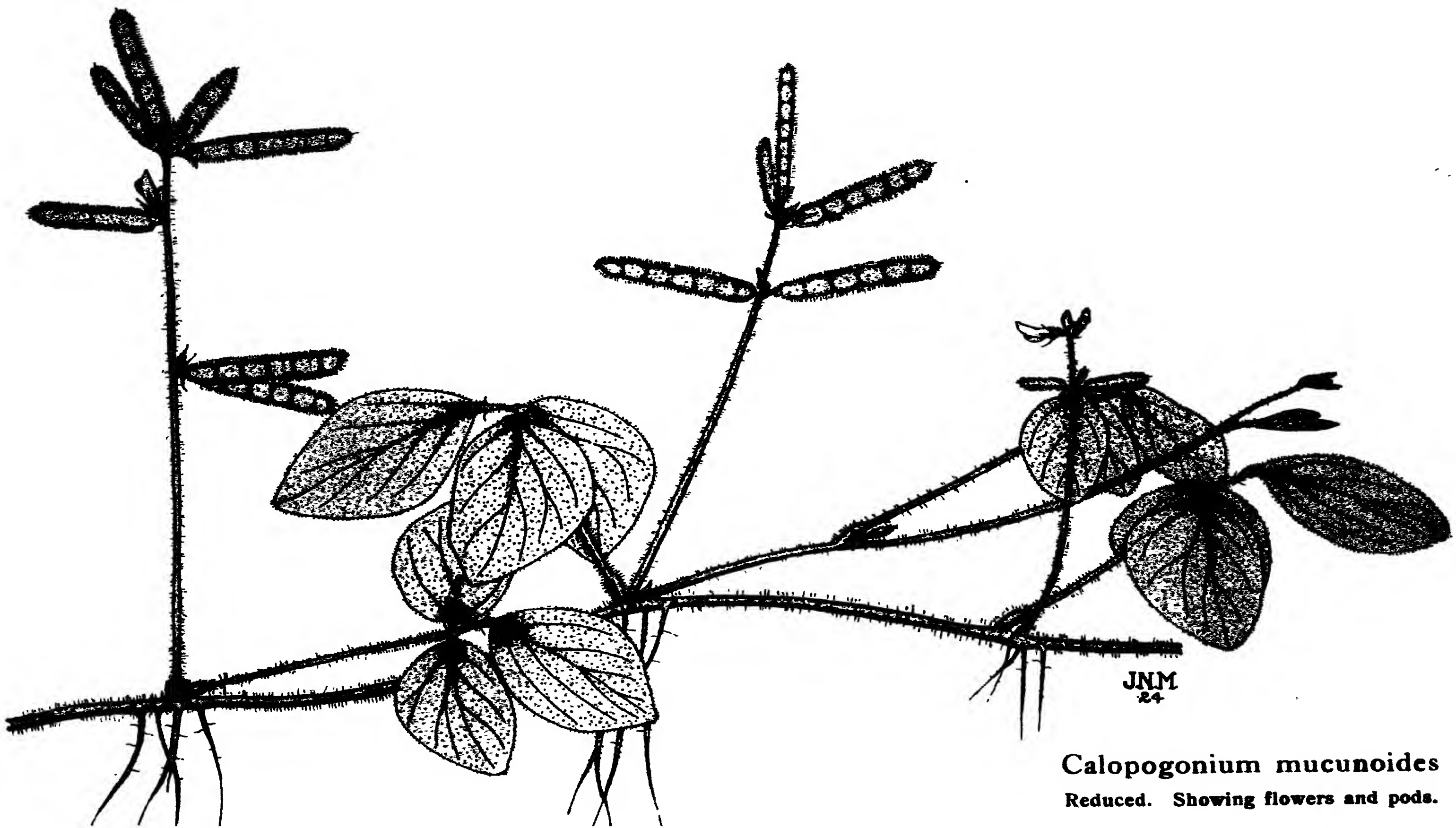
Description.—A vigorous creeping herb, forming a mat of foliage 1½ feet or so in thickness over the soil. The tendrils have a strong twining tendency, ascending in a left hand direction. Length of stems 3 – 10 feet, forming roots below each node, stems succulent, with brown hairs. Stipules triangular, length 2 to 4 millimetres. Leaves trifoliate, leaflets 1 – 5 inches long, 1 – 4 inches broad, hairy on both sides, oval, with round or wedge-shaped base and obtuse apex having a small nerve point. Flowers in racemes, 1 – 4½ inches long covered with brown hairs, small, pale blue, from 4 – 12 on a raceme produced in great profusion. Pod 20 – 40 millimetres long, 4 – 5 millimetres broad, densely covered with brown hairs, 4 – 8 seeds. Seeds small, flattened, brown in colour with thin seed coats. Approximately 33,000 seeds weigh one pound.

According to Keuchenius (2) this legume is known in Java as "Katjang asoe."

Propagation —Seed may be broadcasted on land that has been lightly changkolled but more satisfactory results are obtained by sowing in rows, about three feet apart. In the latter method about 3

(1) Archief voor de Rubbercultuur, Mei 1924, p. 200.

(2) Mededeelingen van het Proefstation voor Thee, No. XC.



Calopogonium mucunoides

Reduced. Showing flowers and pods.

lbs. of seed are required to sow an acre. Germination is encouraged by soaking the seeds in warm water immediately before sowing.

On undulating land that has recently been opened and bunded or silt-pitted, good results are obtained by sowing the seeds fairly thickly in lines on the 'spoil' obtained from the pits or on the sides of the bunds. The seeds commence to germinate within 5 days from sowing and in three months the growth is sufficiently strong to assist materially in holding up the soil supporting the bunds or that from the silt pits As the plants age, the growths spread outwards and become attached to the soil by means of the roots which are thrown out at each node. The plant may be propagated from cuttings but this method is not recommended, as in the field a large percentage of failures occurs owing to the cuttings, which are usually very succulent, drying out.

Habit.--Calopogonium is stated to be intolerant of shade and is useless as a cover plant for old rubber areas Its value lies in its employment as a wash preventative on newly opened undulating land, planted with such crops as rubber or oil palms. It is also likely to be of permanent value under coconuts, though the writers so far have not seen it used extensively for this purpose. Calopogonium is being used successfully on a small area at Castleton Government Plantation, in the Lower Perak district, planted with ten year old coconut palms. The legume has completely covered the land in six months time from sowing and it appears to thrive well on the alluvial clays of this coastal district. A fair cover is formed after three months from sowing when flowering commences. Seeds are produced within a further three months. By this time a dense luxurious cover is formed, through which few weeds are able to penetrate. The growth does not appear to diminish but remains a dense mass of stems and leaves, resulting in a most effective cover over the soil In addition the land is kept in a moist condition and enriched with a large amount of humus matter.

Dr. de Jong, Director of the A.V.R.O S. Experimental Station, Medan, reports a disease attacking Calopogonium in Sumatra but so far this does not appear to be experienced in this country.

The stems of the plant remain succulent and there is unlikely to be any danger of fire occurring during dry weather as has been reported in the case of Giant Mimosa (*Mimosa invisa.*)

The plant is a very profuse seeder and natural reproduction takes place freely where there is sufficient space for the seedlings to thrive.

As far as the writers are aware no seed is harvested for sale at present in this country. Supplies of fresh seed are, however, imported regularly from Sumatra.

Received for publication 11th July 1925.

FORMIC ACID VERSUS ACETIC ACID AS A COAGULANT.

By B. J. Eaton.

OWING to recent interest in and enquiries received concerning the use of formic acid in place of acetic acid as a coagulant for Hevea latex, in the preparation of rubber, the following results and observations on experiments carried out by the writer about ten years ago and published in Bulletin No. 27. "The Preparation and Vulcanisation of Plantation Rubber" (Pages 232—233) may be of value.

The table below, abstracted from the above publication, gives the rate of vulcanisation and tensile figures for samples of fast curing rubber (Slab) coagulated by means of the minimum amount of formic acid (1.5 ozs. of a 5 per cent. solution of formic acid per gallon of standard latex) and also with an excess of the acid equivalent to 33 per cent. above the minimum. For comparison, the figures for a sample coagulated with the minimum amount of acetic acid (approx 3 ozs. of a 5 per cent. solution per gallon of standard latex) are included.

Reference No.	Optimum time of cure. Hours.	Breaking Load (Kilos sq. m.m.) (a)	Elongation at break (Original length=100) (b)	Tensile Product. (a & b)
163.S 1A. ...	1¼	1.50	991	1486
163.S 3B 1 to S 12.B.1	1--1¼	1 38 –1.55	932—1003	1368—1508
163 S.1.B. -S.3.B. ...	1¼	1 43—1.46	957--986	1396·-1409

Sample A is the control sample coagulated with acetic acid; samples B1 (ten samples) are those coagulated with the minimum amount of formic acid; samples B (three samples) are those coagulated with 33 per cent. excess of formic acid.

The figures show that the rate of vulcanisation of the samples coagulated with formic acid compared with that of the acetic acid coagulated sample (Note—Many other acetic acid coagulated samples give similar figures) are similar, while the figures for tensile strength are also equivalent.

Formic acid, which is a "weak" organic acid, is not likely to affect adversely the keeping qualities of the rubber or to have any other deleterious effect on the rubber.

It will also be seen that only about half the quantity of formic acid, compared with acetic acid, is necessary.

Results have been published by other investigators which show different proportions of formic acid compared with acetic acid, but

these differences are probably due to the strength of the original formic acid employed. The strength of the formic acid used in the above experiments was determined by titration.

The "technical" or commercial formic acid on the market is frequently below 100 per cent strength—a well known commercial acid sold being of 85 per cent strength, whereas commercial glacial acetic acid is essentially of 100 per cent strength.

The results show that, if formic acid of 100 per cent. strength can be purchased locally at less then twice the cost of acetic acid, it is more economical than acetic acid as a coagulant. An acid of 80 per cent. strength would have to be less than 1 6 times as expensive as acetic acid to render its use economical.

In purchasing formic acid, buyers should first obtain a guarantee of its strength from the sellers. In the case of glacial acetic acid, the term "glacial" is a technical or trade name which indicates that the acid is essentially 100 per cent. No similar term is used, in the case of formic acid, to indicate its strength.

Recent comparative prices quoted for glacial acetic acid, acetic acid (80 per cent.) and formic Acid (85 per cent.) in England are £67, £41 and £48 per ton respectively.

At these prices the formic acid is much more economical than acetic acid.

An interesting point in connection with the above market prices is that glacial acetic acid is more than 50 per cent higher in cost than 80 per cent acetic acid. Even with the extra freight on 20 per cent of water, it would probably be more economical to import 80 per cent acetic acid (pure) into Malaya for estate use, than to continue the importation of the pure glacial acetic acid.

Buyers should however obtain a guarantee of the strength of the acid from sellers.

Received for publication 2nd July 1925.

THE JAMAICAN OR GROS MICHEL BANANA AND THE PISANG EMBUN OF MALAYA

COMMUNICATIONS have been received by the Department of Agriculture from the West Indies in which it was asked whether the Jamaican or Gros Michel banana is grown in Malaya. These enquiries were made because the Gros Michel variety in those islands is attacked by Panama and other diseases, and efforts were being made to introduce and also to breed strains resistant to disease. It may be mentioned that the Gros Michel variety forms the bulk of the banana export trade from the British West Indies and Central America.

The writer believes that the Malayan Pisang Embun is the same as the Gros Michel banana of the West Indies. Although it has not yet been possible to compare the local and West Indian forms side by side, still from a knowledge of the bananas in both countries, he is of opinion that if they are not identical, they very closely resemble each other.

Fawcett in his book "The Banana, Its Cultivation, Distribution and Commercial Uses" states that "an improvement on the ordinary fruit occurred in Martinique, and eighty years ago M. Jean Francois Pouyat, although he may not have been the first to notice it or the first to propagate it, was yet sufficiently alive to its importance to introduce it into Jamaica. This variety, called at first the Pouyat banana, or the Martinique banana, has become the only one that is cultivated in Jamaica, Costa Rica, and elsewhere for export, and is known now as the Jamaican or Gros Michel banana."

In common with many other Malayan varieties the origin of Pisang Embun is unknown; still, it is unlikely that it was introduced from the West Indies.

The Malays grow another distinct variety of banana which is quite green when ripe and which they term Pisang Embun Lumut or Pisang Masak Hijau—this is sometimes incorrectly referred to as Pisang Embun.

Pisang Embun, which is a variety of Musa sapientum, is grown commonly in native gardens for sale in the local markets. The plants are 15 to 20 feet tall and produce in good soil, large bunches of fruits with 9 to 12 'hands.' Each 'hand' in a bunch is closely packed with 15 to 20 fruits which ripen very evenly. The ripe fruit is 6 to 7½ inches long, 1¼ to 1½ inches in diameter, and bright yellow in colour. It is 3 to 5 angled, but the outer fruits of a 'hand' are, as a rule, more distinctly angled than the inner ones. The skin is tough and fairly thick. The flesh of the fruit is seedless, cream-coloured, sweet and of good flavour and consistency. Rarely a round dark-brown seed

'Pisang' is the Malay word for banana and 'Embun' for dew.

occurs in a fruit; this phenomenon was also noticed by the writer in the Gros Michel variety in the West Indies.

Although the Pisang Embun variety is cultivated in small areas throughout the country and is a favourite market variety no reports of damage done to it by diseases have been received by the Department of Agriculture, still diseases may be present, but owing to the relatively small area planted and the low commercial value of the crop these have not been investigated.

W. N. S.

Received for publication 16th April 1925.

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; and the Malay States Information Agency, 88, Cannon Street, E.C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV (1913-16) VIII & IX (1920-21)			price	$5.00 per volume.
Vol. V	(1917)	Nos. 1, 2, 3, 5 & 6	„	2.50 per set.
„ VI	(1918)	„ 1, 7, 8 & 12	„	2.00 „
„ VII	(1919)	„ 2—6	„	4.50 „

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

Vol. X (1922)	Price $5.00 per volume.
„ XI (1923)	Price $5.00 per volume or 50 cents per single number.
„ XII (1924)	„ „ „ „

Back numbers of Vols. I—X will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased at the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co.

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, Government Entomologist, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher.
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, Government Entomologist, 1910, reprint 1916, 20 cts. (Out of Print.)
4. A Lepidopterous Pest of Coconuts, *Brachartona catoxantha, Hamps*, by H. C. Pratt, 1909.
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909.
6. Preliminary note on a Branch and Stem Disease of *Hevea Brasilienisis*, by W. J. Gallagher, 1909.
7. Coffea Robusta, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910.
9. Die-Back Fungus of Para Rubber and of Cacao, by K. Bancroft, 1911.
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher, 1910.
11. Coconut Cultivation, by L. C. Brown, 1911.
12. Padi Cultivation in Krian, by H. C. Pratt, 1911.
13. A Root Disease of Para Rubber, *Fomes Semitostus*, by K. Bancroft, Assistant Mycologist 1912, 20 cts.

C = Cancelled

THE

Malayan Agricultural Journal.

Vol. XIII.] SEPT., 1925. [No. 9.

BUD-GRAFTING.

IN the current number of the Archief[1] Dr. Heusser continues his records of the "Experimental tapping on Hevea buddings" of which the first and second series were published in January and July last year.

Although the present publication deals with a limited number of trees, the results are of the greatest interest and justify quotation in full.

The clones dealt with in this paper are Avros 33, 36, 50, 52 and 80—further communications are promised giving the results of tapping the other approved clones mentioned in the former reports.

To quote from Dr. Heusser :—

"*Period of tapping.*—The first tapping took place in the spring, the second in the autumn of 1923 In the beginning of 1924 alternate monthly tapping was started and this system has been continued up to the present time. Beginning with the third tapping, as a rule, the buddings were tapped for 25 consequtive days, which works out at 150 tapping days per year.

Tapping cut.—The left cut over half the circumference and the angle of 30° remained the same.

Height of tapping.—The second, third and fourth tapping of clones 33 and 50 was continued on the tapping panel of the first period, which started at a height of 50 c.M. above the union of scion and stock. With the fifth period the panel was changed to the opposite side at a height of 1 M. In the case of clones 36, 52 and 80 the change to 1 M. was made immediately after the second tapping period.

Bark consumption —Care was taken that the bark consumption on an average amounted to 4.5 c.M. (1¾") per period of 25 days, i.e. 27 c.M. (10½") per year.

Tappers.—The buddings were tapped alternately by two moderately good tappers. who were trained by us.

1 Arch v.d. Rubber cultuur—IX No. 8, p. 689, 1925.

"*Determining the production.*—The latex was coagulated in the cup, the coagulum pressed out by hand and fixed on a piece of wire, bearing a zinc label with the number of the tree. After the completion of a tapping period the whole production of each budding was worked up in one piece of crepe, which was numbered and weighed after drying. The average yield per tapping was calculated from the monthly total weight. In this way the supervision of the experimental tappings was considerably simplified.

The tables.—In the tables the average yields per tapping for each period are given in grams of dry rubber. For the sake of completeness the averages of the first tapping are also given. Further the average yield per year and per tapping of the last six tappings, covering one year, is given. For most of the buddings from clones 33, 50, 52 and 80 this is the 6th year of life; for clone 36 it is from $4\frac{1}{4}$ till $5\frac{1}{4}$.

The circumferences of the buddings at a height of 1 M. are also inserted in the tables, because they are to some extent a criterion for the circumstances in which the trees are growing.

(See following tables.)

II. The Yields.

The yield of the buddings increases quickly with the increase of age, a feature also shown by ordinary seedlings of the same age.

Comparing the yields during the months of January or February 1924 with those of the same months of 1925, we see that the yields of clones 36 and 50 are rather more than doubled, and those of clones 33 and 52 nearly doubled. The yield of clône 80 however increases remarkably slowly as compared with the other clones, notwithstanding its vigorous growth.

As to the yield of the individual buddings, tree No. 13 of clone 50 reached the highest yield in the month of March 1925 with 48.76 grams per tapping. The other buddings with a circumference of more than 70 c. M. are not much behind tree No. 13 and it seems that they will become equal to the mother tree.

The correlation between trunk circumference and production is shown clearly. As a rule deviations may be explained externally. For instance tree No. 21 of clone 50 with a low branching and tree No. 16 of clone 33, which was damaged by wind, have a trunk circumference which is too large in proportion to the crown (the part of the tree which really matters). Disturbances in the production also occur during the months of February, March and April, the wintering period of Hevea on the East coast of Sumatra. The larger yields of some of the buddings from clones 33 and 50, when the height of tapping was changed from 40 c.M. to 1 M, must not be wrongly interpreted; the time of changing the height of tapping coincided with the wintering month March and the normal production month May.

"No influence of the stock on the production of the buddings can yet be detected from the tapping results.

Regarding the yielding power of the individual clones during a whole year, April 1924—April 1925, or March 1924—March 1925 respectively the following comment may be made.

Clone 33.—The average yield of the 11 buddings from this clone which were tapped, amounted to 14.68 grams of dry rubber per tapping, the average circumference being 52 c.M.

The production during the whole year, which is with exception of two younger trees, the 6th year, was 2.29 K G. per tree, the total of tapping days being 156.

The average yield per 10 c.M. circumference is 2.84 grams per tapping.

Leaving out of account trees No. 8 and 22 which are younger, the average yield per tapping is 16.3 grams and the yearly production 2.54 K.G.

Clone 36.—The 12 buddings from this clone on an average produced 11.16 grams of dry rubber per tapping per tree in the $4\frac{1}{4}$-$5\frac{1}{4}$ year, the average circumference being 50.25 c.M. The trees were tapped on 128 days only, so the yearly production per tree amounted to 1.43 K.G. only. Expressing the yield per unit of circumference a figure of 2.22 grams per day per 10 c.M. circumference is attained.

Clone 50.—Of 10 buddings of this clone tapped during the year April 1924—April 1925 seven were in the sixth year and three about 1 year younger. The average yield per tapping and per tree was 20.11 grams of dry rubber, the average circumference 64.7 c.M. With 156 tapping days a yearly production of 3.14 K.G. rubber per tree was attained.

Per 10 c.M. circumference the yield amounted to 3.11 grams.

If in calculating the average yield trees No. 1, 11 and 24 which are younger, are not included, the averages per day and per year are 24.59 grams and 3.82 K.G.

Clone 52.—The average yield of the 11 buddings from this clone was 12.98 grams of dry rubber during the 6th year, the average circumference being 60.9 c M. For the whole year, 154 tapping days this means a production of 2.0 K.G. per budding.

Per 10 c.M. circumference a yield of 2.13 grams is calculated.

Clone 80—The 9 buddings from this clone produced 13.04 grams of dry rubber per tree and per day, on an average circumference of 63.3 c.M The production in one year with 154 tapping days is 2 04 K.G. per budding, and the daily yield per 10 c.M. circumference 2.06 grams.

"III. Considerations in Connection with the Budding Problem.

Yield.—The yield of the clones is better than we expected. A well kept up plantation of seedlings from selected seed of the same age produced 8 grams per day, the tapping system being the same. Clone 50, now our best, produces 2½ times as much, notwithstanding the fact that the buddings were tapped at a height of 86 c.M. and the seedlings lower than 50 c.M.

Growth.—The growth of the crown and trunk leaves nothing to be desired; the buddings have become true rubber trees, showing the characteristics of the mother trees. Measurements of the circumferences show, that clone 50 is the most vigorous grower. Clones 80, 52 and 36 follow in this respect: clone 33 grows a little more slowly.

The union of scion and stock.—It seems that the elephant foot of the buddings becomes less pronounced as the plants grow older. A difference between the clones may however still be seen and will probably remain. The union is best in clone 50; the difference in growth of scion and stock is least visible with this clone Clone 80 also unites well, 36 and 52 not quite so well, while clone 33 shows the elephant foot most clearly.

Bark renewal.—Of much more importance than the union, but probably related to it, is the renewal of the bark. Generally speaking this seems to be a little less vigorous than that of well growing seedlings, which are tapped for the first time. This is not so with clone 50 however; the bark renewal of this clone is as good as that of seedlings. The oldest, now 2 years old, renewed bark has an adequate thickness and the panels are beautifully arched and without edges or holes, as is sometimes seen when bark renewal is bad. Also clones 80, 52 and 36 give no cause for uneasiness. Only clone 33, standing on a clay soil, gives the impression that it renews the bark more slowly. In choosing a tapping system for buddings I deem it advisable however to reckon upon a 10 years period for the primary bark.

Fructification.—Clones 36, 33, 50 and 52 bear fruit abundantly. Till now clone 80 has remained sterile, though it has produced many flowers and another flowering clone stands in the same seed garden.

IV. Conclusions for Estate Practice.

In foregoing communications we have advised the use of both buddings and seedlings for new plantations and the planting of these in alternate rows. The above results plead for the abandonment of this point of view and the planting, in the near future, of plantations of buddings only, using clones which are equivalent to the clones described here or still better ones. Only legitimate seedlings and those originating from strictly selected mother trees now deserve to be planted and give any prospect of the same production as buddings from good clones, and even so certainty is not yet obtained, and the productive capacity must be determined for each tree separately. Moreover the available quantity of selected seeds during the next

"years will be limited and insufficient for the new extensions, so in practice one is compelled to use ordinary or only slightly selected seed. Instead of using such seedlings it is much better to plant buddings of good clones exclusively. The advice to plant the different clones well mixed is still maintained, and a warning must be given against planting one clone only.

Under good conditions the yield of a six year old plantation of buddings from the above mentioned or equivalent clones may be estimated at about 400 K.G. per H.A." (about 360 lbs. per acre). "If with the increase in years the production of buddings improves with the same intensity as that of seedlings we may expect the double quantity from a ten years old plantation, or about 800 K.G. per H.A." (about 710 lbs. per acre).

Dr. Heusser's whole hearted advocacy of bud-grafting is noteworthy and is the more striking in view of his former cautious attitude[2]—and of the conservative estimates of yield quoted above. The only criticism which can be made is that the results quoted were from a small number of trees presumably planted and grown under very good conditions, and that even in this small number of clones (five), the best of the original thirty nine—one has at this stage shown a very low rate of increase of yield.*

From a strictly critical point of view it would seem safer to say that the results indicate that the second stage of the experiment has been successfully passed (the first stage being the realisation that not all high yielders "bud true") and that there is good hope of a successful final issue.

For Malaya, this means that the search for 'true' mother trees should be actively pursued, and in this connection the advice given in this Journal[3] in 1923 still holds good. By the time that our trees have been 'proved' it should be possible to have definite information as to the ultimate degree of success attained by bud-grafting with 'proved strains.'

One fact emerges from these results which may have some bearing on recent suggestions for very close planting of unproved strains, and (presumably) subsequent thinning—viz. that while in any clone 'yielding power' $\frac{(\text{Yield})}{(\text{Girth})}$ is uniform—*yield* is very decidedly not uniform. From this it seems fair to deduce that high actual yield is much more closely connected with girth than is the case with seedlings and therefore that ample space for full development is necessary for the real capacity of any tree to be ascertained. Failing such wide spacing, it might be possible for accidental variations of soil, 'get away,' and the like, te lead to misleading conclusions from early tappings.

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2 c.f. M.A.J., XII No. 9 p 344, 1924.

* a fact pointed out by Dr. Heusser himself.

3. M.A.J., XI No. 2 p 29 1923.

No.	Clone *Avros 33* Budding		Average yield per tapping day in grams during the month of										Average
			March '23	Oct. '23	Jan. '24	March '24	May '24	July '24	Sept. '24	Nov. '24	Jan. '25	March '25	4—'24—4—'25
			Height of tapping in c.M.										
			50	46,5	43	40	100	95,5	91	86,5	82	77,5	86,5
			Number of tapping days										
			20	20	15	28	28	28	25	25	25	25	Total 156
1	Yield	...	5,90	7,23	14,16	13,67	12,55	12,02	14,00	17,60	25,46	23,70	17,56
	Circumference	...	*39*	*47*	—	*50*	—	—	*56*		—	—	*56*
2	Yield	...	6,30	6,65	12,51	6,82	9,58	8,43	11,96	13,72	21,60	18,48	13,96
	Circumference	...	*40*	*44*	—	*48*		—	*52*	—	—	—	*52*
6	Yield	...	4,13	5,62	8,34	6,98	10,80	9,03	12,36	14,84	19,24	18,76	14,17
	Circumference	...	*33*	*41*	—	*44*	—	—	*50*	—	—	—	*50*
8	Yield	...	—	3,35	7,11	3,72	6,36	5,37	7,33	11,26	14,42	12,16	9,48
	Circumference	...	—	*33*	—	*36*	—	—	*42*	—	—	—	*42*
11	Yield	...	8,79	8,90	15,59	9,50	15,09	12,90	19,20	22,24	30,72	28,52	21,45
	Circumference	...	*47*	*53*	—	*56*	—	—	*60*	—	—	—	*60*
13	Yield	...	2,64	4,59	9,25	5,26	8,09	8,14	10,46	13,16	19,60	16,10	12,59
	Circumference	...	*32*	*43*	—	*47*	—	—	*50*	—	—	—	*50*
15	Yield	...	6,13	7,39	11,29	8,44	11,40	11,21	12,46	17,08	23,88	19,84	15,98
	Circumference	...	*34*	*39*	—	*44*	—	—	*49*	—	—	—	*49*
16	Yield	...	5,09	5,71	10,40	6,22	7,82	7,42	10,50	10,96	15,40	14,10	11,03
	Circumference	...	*43*	*50*	—	*54,5*	—	—	*61*	—	—	—	*61*
18	Yield	...	7,63	8,99	17,49	15,21	13,82	11,80	19,06	22,12	30,60	25,40	20,47
	Circumference	...	*43*	*50*	—	*54*	—	—	*59*	—	—	—	*59*
22	Yield	...	—	2,89	7,11	3,04	3,45	3,65	5,34	6,20	9,20	7,24	5,85
	Circumference	...	—	*33*	—	*37*	—	—	*38*	—	—	—	*38*
23	Yield	...	7,97	7,97	13,31	9,74	11,80	13,15	18,38	19,99	26,28	23,84	18,90
	Circumference	...	*42*	*47*	—	*50*	—	—	*55*	—	—	—	*55*
	Average	Yield	6,06	6,30	11,51	8,05	10,07	9,37	12,82	15,38	21,49	18,92	14,68
		Circ.	*39,2*	*43,3*	—	*47,2*	—	—	*52,-*	—	—	—	*52*

No.	Clone Avros 50 Budding		March '20	Oct. '23	Jan. '24	March '24	May '24	July '24	Sept. '24	Nov. '24	Jan '25	March '25	Average 4—'24—4—'25
			Average yield per tapping day in grams during the month of										
		Height of tapping in c.M	50	46,5	43	40	100	95,5	91	86,5	82	77,5	86,5
		Number of tapping days	20	20	15	28	28	28	25	25	25	25	Total 156
1	Yield	...	—	2,04	5,37	6,18	4,57	5,10	8,13	9,14	12,84	13,32	8,85
	Circumference	...	—	*31*	—	*38*	—	—	*44*	—	—	—	*44*
11	Yield	...	—	2,47	5,38	5,47	6,15	7,12	10,78	12,66	14,74	16,24	11,28
	Circumference	...	—	*36*	—	*41*	—	—	*48*	—	—	—	*48*
12	Yield	...	4,92	10,36	16,65	17,76	10,70	13,25	24,00	20,60	30,78	26,40	20,96
	Circumference	...	*48*	*55*	—	*61*	—	—	*69*	—	—	—	*69*
13	Yield	...	8,39	10,74	16,74	13,78	19,48	21,39	29,77	23,92	38,80	48,76	31,18
	Circumference	...	*58*	*64*	—	*69*	—	—	*75*	—	—	—	*75*
14	Yield	...	10,20	11,39	21,56	17,79	20,38	16,30	25,82	28,56	43,20	41,94	29,37
	Circumference	...	*58*	*66*	—	*71*	—	—	*79*	—	—	—	*79*
16	Yield	...	3,76	6,50	14,11	14,07	9,89	13,02	17,59	16,22	24,98	24,96	17,78
	Circumference	...	*46*	*52*	—	*55*	—	—	*62*	—	—	—	*62*
20	Yield	...	9,30	10,39	20,39	11,11	17,62	19,43	27,48	26,84	38,48	36,48	27,72
	Circumference	...	*60*	*66*	—	*69*	—	—	*75*	—	—	—	*75*
21	Yield	...	7,03	9,88	14,97	11,10	19,66	20,06	24,60	26,48	37,72	25,80	25,72
	Circumference	...	*55*	*66*	—	*71*	—	—	*77*	—		—	*77*
23	Yield	...	5,52	6,89	14,24	13,36	12,62	14,03	19,60	20,36	27,68	22,26	19,43
	Circumference	...	*63*	*61*	—	*67*	—	—	*74*	—	—	—	*74*
24	Yield	...	—	2,27	4,41	8,18	5,09	6,40	8,83	8,98	13,42	9,97	8,78
	Circumference	...	—	*31*	—	*38*	—	—	*44*	—	—	—	*44*
	Average	Yield	7,02	7,29	13,38	11,38	12,62	13,61	19,66	19,88	28,26	26,61	20,11
		Circ.	*54*	*5,27*	—	*57,9*	—	—	*64,7*	—	—	—	*64,7*

No.	Clone Avros 36 Budding		Jan. '23	Oct. '23	Febr. '24	April '24	June '24	Aug. '24	Oct. '24	Dec. '24	Febr. '25	Average 3—'24—3—'25
			Average yield per tapping day in grams during the month of									
			Height of tapping in c.M.									
			50	46	100	96	92	88	84	80	76	86
			Number of tapping days									
			20	20	19	21	18	22	23	23	21	Total 128
1	Yield	...	0,80	3,58	4,98	5,74	5,75	8,48	11,08	13,17	13,74	9,66
	Circumference	...	*25*	*33*	—	—	—	—	*46*	—	—	*46*
2	Yield	...	3,90	7,51	8,50	5,03	9,76	11,54	14,35	19,59	11,05	11,87
	Circumference	...	*33*	*39*	—	—	—	—	*49*	—	—	*49*
3	Yield	...	4,02	7,08	3,68	5,74	2,81	7,23	7,67	12,61	11,33	7,90
	Circumference	...	*35*	*41*	—	—	—	—	*48*	—	—	*48*
4	Yield	...	3,23	4,76	7,32	4,76	4,20	8,97	9,09	5,29	4,62	6,16
	Circumference	...	*35*	*41*	—	—	—	—	*51*	—	—	*51*
6	Yield	...	3,25	3,72	5,98	3,06	5,93	7,22	9,78	14,02	13,52	8,92
	Circumference	...	*33*	*36*	—	—	—	—	*49*	—	—	*49*
7	Yield	...	3,47	6,67	8,29	8,41	9,63	13,27	15,25	20,09	19,14	14,30
	Circumference	...	*35*	*42*	—	—	—	—	*53*	—	—	*53*
17	Yield	...	3,31	8,26	3,05	8,40	7,85	12,90	16,72	20,53	12,63	13,17
	Circumference	...	*36*	*42*	—	—	—	—	*52*	—	—	*52*
20	Yield	...	3,24	5,65	7,91	9,43	11,12	11,13	17,08	21,95	18,43	14,86
	Circumference	...	*39*	*44*	—	—	—	—	*56*	—	—	*56*
23	Yield	...	—	3,54	4,68	6,28	7,42	10,60	13,83	18,15	11,46	11,29
	Circumference	...	—	—	—	—	—	—	*50*	—	—	*50*
25	Yield	...	2,97	4,83	5,79	7,74	7,59	11,45	15,56	20,53	18,14	13,50
	Circumference	...	*31*	*37*	—	—	—	—	*48*	—	—	*48*
27	Yield	...	—	9,35	6,27	9,62	8,92	14,04	15,60	24,04	17,12	14,89
	Circumference	...	—	—	—	—	—	—	*55*	—	—	*55*
33	Yield	...	—	—	—	—	1,95	5,59	7,40	12,28	10,51	7,55
	Circumference	...	—	—	—	—	—	—	*46*	—	—	*46*
	Average	Yield	3,14	5,90	6,04	6,75	6,92	10,20	12,78	16,85	13,47	11,16
		Circ.	*33,5*	*39,4*	—	—	—	—	*59,25*	—	—	*50,25*

No.	Clone *Avros 80* Budding		Febr. '23	Oct. '23	Dec. '23	Febr '24	April '24	June '24	Aug. '24	Oct. '24	Dec. '24	Febr. '25	Average 3—'24—3—'25
			Average yield per tapping day in grams during the month of										
		Height of tapping in c.M.	50	46,5	100	95,5	92	87,5	83	78.5	71	69,5	78,5
		Number of tapping days	20	20	14	20	28	26	25	25	25	25	Total 154
1	Yield	...	6,30	7,90	7,94	8,21	3,80	7,29	7,64	6,80	4,32	1,46[1])	5,22
	Circumference	...	*40*	*48*	—	—	—	—	—	*55*	—	—	*55*
3	Yield	...	3,98	6,69	8,71	9,96	7,96	8,17	8,92	10,25	13,54	12,50	10,22
	Circumference	...	*38*	*49*	—	—	—	—	—	*60*	—	—	*60*
4	Yield	...	8,59	11,50	15,03	16,83	9,92	16,85	14,54	21,04	16,50	12,62	15,25
	Circumference	...	*51*	*56*	—	—	—	—	—	*65*	—	—	*65*
6	Yield	...	3.75	9,23	9.72	9,64	8,74	9,51	8,96	10,72	16,12	15,34	11,57
	Circumference	...	*38*	*46*	—	—	—	—	—	*57*	—	—	*57*
11	Yield	...	5,93	8,96	7.59	8,80	6,35	8,44	8,54	9,22	11,20	9,26	8,84
	Circumference	...	*39*	*43*	—	—	—	—	—	*51*	—	—	*51*
14	Yield	...	4,65	9,50	12.34	12,35	7,36	11,78	12,14	13,48	11,04	15,06	11,81
	Circumference	...	*46*	*52*	—	—	—	—	—	*67*	—	—	*67*
16	Yield	...	13,66	17,40	21,53	24,41	14,82	22,01	20,22	26,16	29,64	33,16	24,34
	Circumference	...	*63*	*72*	—	—	—	—	—	*82*	—	—	*82*
22	Yield	...	7,85	11,09	13,35	13,89	8,10	11,96	11,84	14,28	13,40	14,58	12,36
	Circumference	...	*50*	*55*	—	—	—	—	—	*63*	—	—	*63*
25	Yield	...	10,54	14,09	14,48	15,92	12.68	17,59	15,32	18,28	21,48	21,06	17,74
	Circumference	...	*52*	*60*	—	—	—	—	—	*70*	—	—	*70*
	Average	Yield	7,25	10.74	12,30	13,17	8,86	12,62	12,01	14,47	15,25	15,00	13.04
		Circ.	*46,3*	*54,5*	—	—	—	—	—	*63,3*	—	—	*63,3*

[1]) Part of the crown lost in consequence of Djamoer oepas (Corticium).

No.	Clone Avros 52 Budding		Febr. '23	Oct. '23	Dec. '23	Febr. '24	April '24	June '24	Aug. '24	Oct. '24	Dec. '24	Febr. '25	Average 3—'24—3—'25
			Average yield per tapping day in grams during the month of										
		Height of tapping in c.M.	50	46,5	100	95,5	92	87,5	83	78,5	74	69,5	78,5
		Number of tapping days	20	20	14	20	28	26	25	25	25	25	Total 154
3	Yield	...	6,69	8,39	4,46	7.46	6,26	9.08	7,44	14,16	14,12	22,60	12,28
	Circumference	...	*42*	*45*	—	—	—	—	—	*53*	—	—	*53*
4	Yield	...	10,30	17,22	11,10	8,42	7,26	11,66	14,70	17,80	16,72	20,96	14,85
	Circumference	...	*51*	*57*	—	—	—	—	—	*66*	—	—	*66*
5	Yield	...	4,44	5,76	3,15	3,76	5,71	9,02	8.12	9,12	11,12	11,24	9,06
	Circumference	...	*37*	*43*	—	—	—	—	—	*50*	—	—	*50*
6	Yield	...	11,18	15,54	11,84	15,41	10,01	15,72	17,14	17,32	13,68	19,60	15,58
	Circumference	...	*56*	*62*	—	—	—	—	—	*69*	—	—	*69*
10	Yield	...	9,43	14,54	11,79	13.45	8,94	14,57	16,52	20,36	22,70	24.28	17,90
	Circumference	...	*50*	*54*	—	—	—	—	—	*63*	—	—	*63*
11	Yield	...	9,38	8,96	8,79	12,02	9.94	10,87	10,80	12,64	11,32	16,94	11,75
	Circumference	...	*49*	*54*	—	—	—	—	—	*61*	—	—	*61*
14	Yield	...	3.27	7,16	6,97	7,84	6.71	7,92	8,38	9,16	10,72	14,76	9,61
	Circumference	...	*36*	*44*	—	—	—	—	—	*57*	—	—	*57*
15	Yield	...	5,84	8,42	12,21	14.17	8,56	12,80	12,96	14,48	13,56	22,80	14,19
	Circ unference	...	*48*	*56*	—	—	—	—	—	*66*	—	—	*66*
18	Yield	...	7.30	9,45	9,52	12,88	9,94	10,48	11,46	12,32	12,82	21,26	13,05
	Circumference	...	*45*	*54*	—	—	—	—	—	*62*		—	*62*
20	Yield	...	2,77	7.47	6,99	5,71	4,90	7,32	8,34	10,92	10,86	14,66	9,50
	Circumference	...	*33*	*45*	—	—	—	—	—	*57*	—	—	*57*
21	Yield	...	8,63	15,03	11,42	11,53	9,84	14,26	13,88	16,20	22,10	13,60	14,98
	Circumference	...	*49*	*56*	—	—	—	—	—	*66*	—	—	*66*
	Average	Yield	7,00	10,72	8,93	10,24	7,82	11,25	11,79	14,04	14,52	18,43	12,98
		Circ.	*45*	*51,8*	—	—	—	—	—	*60,9*	—	—	*60,9*

TAPPING SYSTEMS AND OTHER FACTORS INFLUENCING YIELD OF HEVEA BRASILIENSIS.

By F. G. Spring.

THIS article is based on the results of tapping experiments carried out on numerous rubber estates throughout the Peninsula, results of which were kindly supplied to the Department of Agriculture.

The writer is not familiar with the conditions under which the experiments were conducted and cannot therefore make any comment as to the accuracy of the results. Unfortunately little information was given in respect of many of the tests and in several instances the results had to be omitted owing to the absence of sufficient data.

Tapping experiments require special knowledge in their preparation and a high standard of supervision. It is not proposed here, however, to deal with the principals which should govern field tests with the rubber tree but merely to draw attention to the fact that there are many problems to be considered since so many factors have a direct influence on the yield of latex. If any estate Manager contemplates conducting tapping experiments it is advisable that he should first consult the Department of Agriculture.

Yields during wintering and at other times.

The following comments were made on the results obtained on six estates.

Estate 1.—" The best yielding period is from October to the middle of February. The crop, during the wintering season, decreases to a greater extent on flat land than on undulating land."

Estate 2.—"The crops steadily fall off from March and do not recover until the trees have put on fresh foliage, which is usually during the month of June. Should a period of drought be experienced the yields will be affected, provided the duration of the drought is sufficiently long, say two weeks."

Estate 3.—" The best yielding month is December "
" The poorest yielding month is April."

Estate 4.—" There is less falling off in yield due to wintering with alternate day tapping as compared with daily."

Estate 5.—" The harvests generally begin to fall away, owing to leaf change (wintering) about the middle of February until the crop reaches its lowest point towards the end of March. Two or three weeks later, a slight increase in crop is noticed and this increase is generally steadily maintained until the crop becomes normal about

the middle or end of May. The influence of wintering is felt over a period of around 3½ months. A spell of dry weather before wintering commences is responsible for fairly regular leaf fall throughout the estate. Heavy rains immediately preceeding the wintering season induce trees to retain old foliage longer than they would otherwise. Under such circumstances, wintering is not only retarded but often very irregular and the period over which poorer yields are obtained, is extended. The output almost invariably touches its lowest point when the new foliage is bursting. The best yielding months are November, December and January."

Estate 6.—" The crop drops considerably during the wintering season and if the wintering is heavy, the reduction may be as high as 50%. The crop is larger during wet weather, provided the rains do not interfere with tapping to any great extent."

Hour of Tapping.

The following comments were made on the results obtained on 5 estates.

Estate 1.—Late tapping produces about 60% of a normal crop obtained from early tapping.

Estate 2.—With late tapping, the output from any daily system is more adversely affected than in the case of alternate day tapping.

Estate 3.—A loss of from 25 to 40% of the crop is experienced when tapping is started late. Afternoon tapping (vacant tasks) gives approximately 60% of normal yields.

Estate 4.—The yield obtained, when tapping was commenced at 2 p. m., never exceeded 50% of a normal day's crop.

Estate 5.—Late tapping is responsible for a loss in crop of 25% of the yield obtained from early tapping.

It has been proved in Java and Sumatra[1] that early tapping produces a higher yield than later in the day and that the yield decreases especially after 9 a.m.

Daily Versus Alternate Day Tapping.

A few years ago, daily tapping was popular throughout the Peninsula but the majority of estates here are now working on the alternate day system which is a more economical one and a few on periodical tapping. Some experiments have shown that alternate day tapping produces about 70% of the yield as compared with daily, over a period, with equal lengths of tapping cut but if the length of the cut in the alternate day system be increased, a more favourable comparison does it make.

1 Dr. J. G. J. A. Mass, Archief, January 1925, page 215.

The Mycologist S.S. and F.M.S. is of opinion that alternate day tapping from the disease point of view is to be recommended in preference to any system of daily tapping. R.M. Richards has also expressed a similar opinion.[1]

Estate 1.—A test was conducted over a period of two years to compare the yields obtained from a quarter cut daily and from a V cut alternate day. The fields are similar in size and the cuts were practically at the same height from the ground.

System.	Yield 1st Year	Yield 2nd Year.
¼ cut daily	595 lbs per acre	563 lbs per acre
V cut Alternate day	605 „ „ „	703 „ „ „

It will be seen that as tapping continues the more favourable does the yield of the alternate day system become. With the V, there was a saving of just over 1½ cents per lb. in cost.

Estate 2.—On this property the system was changed from a fairly low, daily third cut, to an alternate day ½ cut. After six months tapping approximately 95% of the former crop was obtained.

Estate 3.—The system was changed from a third cut daily to ½ cut alternate day and the new system yielded approximately 90% of the former crop.

Estate 4.—During the year 1920 the trees were tapped daily on the quarter cut and during 1921 and 1922 they were tapped alternate daily on the ½ cut.

Year.	Yield per Acre.	Yield per Tree.	Cost of Tapping.
1920	220 lbs.	2.66 lbs.	9.04 cents.
1921	203 „	2.59 „	5.62 „
1922	257 „	3.28 „	4.81 „

The yields for 1922 are calculated on seven months results.

Estate 5.—When the trees were 10 years old a change was made from daily to alternate day tapping, quarter cut. It is reported that 15 to 16 year old trees are producing rather more on a ¼ cut, alternate day tapping, than they did at the age of 10 to 11 years when they were tapped daily.

Tapping at Intervals of More than two days.

Numerous experiments have been carried out to enquire into the prospects of tapping at intervals of more than two days but there is not sufficient evidence to enable definite recommendations to be made.

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1 Lectures delivered at the Planters' Conference, Kuala Lumpur, July 1924, page 52.

Estate 1.

SYSTEM OF TAPPING V ON HALF THE CIRCUMFERENCE.

Area.	System.	Total Yield.	Yield per Acre.	No. of tapping months.
(1) 10 acres	Alternate day.	2765 lbs.	276 lbs.	10
(2) 20 acres	every 3rd day.	5341 „	267 „	11

(1) Bark consumption at the rate of 9" per annum.

(2) „ „ „ „ „ „ 6" „ „

In (1) tapping was conducted over a period of 10 months whereas in (2) the period was 11 months.

The land is flat and of a clay texture.

Estate 2.—Two superimposed ¼ cuts tapped every 3rd day yielded 47.70 per cent of the crop obtained from 2 superimposed cuts ¼ circumference daily tapping over a period of two years (5592 lbs. against 11724 lbs.) The higher cut being 36 inches and the lower cut 20 inches from the ground. The areas are similar in size and appearance. One experiment carried out in Ceylon showed that the relation in yield between alternate day tapping and tapping every third day to be approximately 5 to 4. The system was one cut half the circumference of the tree in both cases.

PERIODICAL TAPPING.

On one estate in Malaya the yields obtained, per acre, over a period of 12 months, on alternate month tapping, were higher than that obtained from alternate day tapping but on another estate the Manager reports that he discontinued the daily tapping with periods of rest as the results were so inferior to that obtained from alternate day tapping.

In the Archief, Januari, 1925, page 218 it is reported "For the time being the conclusions arrived at are that resting periods may vary from ½ to 2 months, but that these may not last longer than two months, whilst the tapping periods should not be shorter than one month and not longer than two months. The record of the daily yields and the changes as far as the rubber content of the latex is concerned, furnish indications as to the proper duration of the tapping periods as compared with the duration of the preceeding resting."

" As regards the influence of resting periods on the intrinsic characteristics of the rubber, De Vries stated that resting periods of more than two months only caused marked deviations in the uniformity. Uniformity should however not be taken for quality and it should further be kept in mind that not all the sections of an estate are rested at the same time and therefore latex obtained from

trees which have just been rested, is mixed in the factory with latex from other sections."

A. B. C. System.

In the A. B. C. system the area is divided into three equal divisions and each tapped in turn for equal lengths of time, the trees are therefore rested for double the time they are in tapping. The period over which tapping should be continued has not been definitely decided. The following are the results obtained with the A. B. C. system on one cut half the circumference of the tree daily tapping, as compared with the control plots which were tapped on alternate days on half the circumference of the tree :—

Estate	A.	A.B.C. system	yielded	69%	of	the	crop	of	the	control.
,,	B.	,,	,,	62%	,,	,,	,,	,,	,,	,,
,,	C.	,,	,,	72%	,,	,,	,,	,,	,,	,,
,,	D.	,,	,,	80%	,,	,,	,,	,,	,,	,,
,,	E.	,,	,,	81%	,,	,,	,,	,,	,,	,,
,,	F.	,,	,,	67%	,,	,,	,,	,,	,,	,,
,,	G.	,,	,,	80%	,,	,,	,,	,,	,,	,,

One Manager who tried this system for two years came to the conclusion that he obtained 81% of normal output with 66% of the labour and bark. Mr. C. R. Harrison of Midlands Estate, Klang, delivered an interesting lecture at the 2nd Planters' Conference, Kuala Lumpur on Periodic Tapping in which he dealt with a system of tapping evolved by himself namely alternate day A. B. C. on half the tree. The method is to divide the area into three equal parts called for convenience A.B.C. Tap sections A & B on alternate days, while C is rested. Stop tapping A section after a fixed period, then tap B—C and so on. This lecture will no doubt be published.

Number of Cuts to a Tree.

It is reported that an experiment was started on June 1st 1914, and continued until the end of 1917, the object being to record the difference in yields obtained from a single cut on the quarter, and from two cuts on a quarter; daily tapping in both cases. The trees were 7 years old at the time the experiment was started, the appearance of the trees in both areas was very similar, and as far as could be judged, all other conditions were equal.

The average amount of No. 1 rubber collected, per coolie, during each year was:—

Year.	Average yield per cooly per annum obtained from 2 cuts on the quarter.	Average yield per cooly per annum obtained from a single cut on the quarter.
1914	671.07 lbs. (for 7 months)	643.55 lbs. (for 7 months).
1915	1,307.97 ,,	1,282.68 ,,
1916	1,979.00 ,,	1,987.65 ,,
1917	1,929.06 ,,	1,896.00 ,,
	5,887.10 lbs.	5,809.88 lbs.

Notes on the experiments :—

(1) Each cooly tapped 400 trees per day, irrespective of whether trees had one out or two cuts.

(2) Over the areas where the trees had single cuts, all cuts were opened at 20 inches from the ground. Trees on which two cuts were tapped had the upper cut at 36 inches from the ground and the lower cut at 20 inches from the ground.

(3) By the end of 1917, the bark renewal on trees which had been tapped with two cuts was so poor, that it was quite evident that this system of tapping was far too drastic.

(4) The yield obtained from a single cut was 98.69% of that obtained from a double cut.

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A PRELIMINARY NOTE ON PINEAPPLE FIBRE.

By R. O. Bishop & E. A. Curtler.

VARIOUS species of the Natural Order Bromeliaceae have long been known as potential sources of fibre and it appears that the variety *Ananas sativus*, known universally for its fruit, the pineapple, has for many years been recognised by the inhabitants of these parts as a plant of which the leaf contains a valuable fibre. It is reported[1] that in the Great Exhibition of London, 1851, pineapple thread of high quality was exhibited as having been made in Singapore, and the same writer[2] states that, in the East Indies, fibres of *Ananas sativus* have been extensively used for the manufacture of a fabric (Pina cloth) and cordage. (It appears however that Squier was referring to another variety of edible pineapple.) A sample of pineapple fibre was taken to England in 1893 by an Assistant Superintendent, Gardens and Forest Department, Straits Settlements and very favourably reported on by Messrs Ide & Christie[3]. A somewhat extensive investigation into the preparation of fibre from the leaves of the Red Spanish pineapple grown in Florida was reported by the U.S.A. Department of Agriculture in 1892[4]. From an Appendix to a Foreign Office Report (F.O. Commercial 1 1896) we learn that Pineapple fibre was at that time an article of commerce in the island of Formosa from whence it was exported to Swatow to be made into cloth. The fibre was valued at about $21, - per picul[5].

More modern publications contain however only brief references to the fibre obtained from the leaves of the edible pineapple plant, and there appears to be no information of a precise nature to meet the requirements of any capitalist likely to exploit pineapple fibre as an industrial enterprise. With the object of supplying this deficiency some experimental work has been carried out at the Department of Agriculture and the results are recorded in this article.

Commercial Valuation of the Fibre.—In August 1924 a representative sample of fibre was prepared from pineapple plants grown for the fruit canning factory at Klang, Selangor, and the sample was submitted to the Imperial Institute for valuation and report. The results of examination, indicate that the fibre is of good quality, and although only fairly well prepared, it would probably be saleable at about £50 per ton, if offered in commercial quantities. As the commercial valuation was slightly above that of first quality Sisal Hemp and approximately seventy five per cent. of the value of the finest Manila Hemp it appeared desirable to continue investigations by stripping fibre from the leaves of plants growing at the Government Experimental Plantation, Serdang.

1. Tropical Fibres, Squier, page 37.
2. Ibid.
3. Kew Bulletin 1893 page 368.
4. Kew Bulletin 1893 page 208
5. Kew Bulletin 1896 page 73.

Yield of Fibre.—The plants selected were of the "Singapore" variety which is the one grown in this country for canning factories. The fruit is about six inches long with a maximum girth of fifteen inches and an average weight of two and three quarter pounds. The leaves are dark green with a silver-grey cuticle on the underside. There are no spines on the edges of the leaves.

The plants were grown in a field of 8½ acres situated on the eastern slope of a slight rise. The soil is a light sandy loam overlying laterite. The area in question carried no crop from the time it was cleared of jungle until the pineapple suckers were planted, except for a light growth of Centrosema Plumerii which was planted immediately after clearing, and ploughed in 12 months later, when the land was prepared for the pineapples.

The suckers, which had been obtained from Singapore, were planted in rows five feet apart across the face of the hill, with three feet between the individual suckers. Planting took place during February and March 1923. The leaves for fibre decortication were harvested during December 1924, and January to March 1925. Table 1 shows the yields of fibre obtained from the leaves cut in the respective months.

TABLE I.

Yield of fibre from Pineapple Leaves.

—	Number of leaves.	Wt. of leaves. lbs	Wt. of Fibre. lbs.	Percentage Yield of Fibre from green leaves.
Dec. 1924	40485	9102	104 5	1.14
Jan. 1925	42279	12400	124.75	1 00
Feb. 1925	34327	8675	88 25	1.01
Mar. 1925	47370	11185	113 625	1.01

A few leaves were harvested and decorticated prior to December.

Total Leaves Decorticated	... 169500
Total Weight of Wet Leaf	... 43240 lbs.
„ „ Dry Fibre	... 448.5 „
Yield of Dry Fibre/Wet Leaf	... 1.02 per cent.

The fruit of the pine was being harvested throughout this period of leaf gathering but the main crop of pineapples was not ripe until May/June 1925. The total yield of fruit harvested from the 8½ acres up to the end of June 1925 was approximately 10,000 pineapples.

Although from field observations we are unable to record any definite ill effect caused by the stripping of these leaves it is thought that a better yield of both leaf and fruit would have been obtained if the leaf harvest had been postponed until May and June 1925 i.e. practically simultaneous with the gathering of the bulk of the fruit, but before any definite figures can be obtained it will be necessary to conduct more intensive trials and the history of the whole area would need to be recorded systematically over at least 3 years. As far as we can say at present the stripping of 20 tons of leaves from the 8¼ acres has had no apparent effect.

The leaves, which have no spines along their edges, are harvested simply by pulling. A firm grip near the base of the leaf is sufficient to enable a coolie to strip the leaf from the plant stem with comparative ease.

The average dimensions of the freshly stripped leaves were :—

Length	... 43	inches
Width	... 2¼	,,
Weight	... 4	ozs.

The leaves, as shown in Table 1, were cut in quantities of five thousand at a time and transported to Kuala Lumpur, a distance of fifteen miles, where they were stripped at the rate of two thousand per day. It did not appear that the quality of the fibre deteriorated in any way by this delay in handling and, in comparison with Sisal Hemp, which is a more fleshy leaf, the pineapple leaves allow greater latitude in time and conditions of storage without showing the depreciation in colour and appearance of the finished fibre that is apparent in Sisal Hemp.

The fibre was decorticated from the pineapple leaves in two stages. The leaf was first run between the smooth rollers of a rubber machine, by means of which it was flattened and the surface cuticle on both sides of the leaf bruised and softened ; the crushed leaf was then stripped in a raspador machine. It was found that the fibre after this treatment was still contaminated with adherent tissue which could only be removed by washing and scraping with a blunt knife. The raspador machine designed to deal with large succulent leaves such as Sisal could not be arranged to strip the pineapple leaves clean because the leaf cuticle is tougher and the fibre is very much finer than Sisal hemp. It was therefore only possible with the machine at our disposal to remove a portion of the surrounding tissue from the fibre filaments and, even then, great care had to be exercised with the adjustment of the raspador, to prevent loss of fibre. Doubtless, if the demand arose, a suitable machine could be devised but it is interesting to note that the U. S. A. Department of Agriculture Report on Fibre Investigations, 1892, comments on the same difficulty in extracting pineapple fibre[4]. The value of pineapple fibre was recognised many years ago by Ridley[7; 8] but he concluded that the

7. Agr: Bull: of the Malay Peninsula. No. 3 May 1893 page 56.
8. Agr: Bull: Straits and F.M.S. Vol. IV. No. 1 Jan. 1905 page 6.

hardness of the epidermis of the leaf made it difficult to produce the fibre economically in large quantities.

The question of a suitable machine has a very important bearing on the commercial production of fibre from this and other species of Bromeliaceae and, as far as we are aware, there is still no efficient machine on the market for dealing with this class of fibres.

Quality of the Fibre.—The fibre when dry and brushed was submitted to an examination for tensile strength and chemical characteristics in comparison with standard specimens of Manila hemp. Well prepared pineapple fibre should find applications other than for cordage purposes, and it is known that the finest Manila Hemp,—Philippine Islands, Government Grade, Prime "A",— is used for semi-textile purposes and not cordage. It was thought therefore that such a fibre would afford the most useful criteria for evaluating pineapple fibre.

Microscopic examination of the ultimate fibres has not been carried out thoroughly, but the measurements so far made show that the fibre filament of the material under examination consists of bundles of ultimate fibres which have the same dimensions as those recorded by Vetillard[6].

—	Pineapple Fibre.	Prime Manila Hemp.	Linen.	Jute.
Length of Raw Fibre Filament in inches	36 42	84.96	...	40.48
Mean length of Ultimate Fibres in millimetres	5.0	6 0	25.0	2 0
Mean breadth of Ultimate Fibres in 1/1000 m.m	6.	24.	20.	22.5

The tensile strength of the fibre was determined on a Schopper fibre Testing Machine according to the procedure adopted in testing fibres at the Department of Agriculture The figures recorded in Table II show the results obtained. Each specimen of fibre is broken in two places — at either end — and the mean of the two breaking loads is used for calculating tensile strength in Kilos per unit gramme length.

6. Textile Fibres. Mathews page 134.

TABLE II.

Tensile Strength Determinations on Pineapple Fibre.

Specimen No.	Weight of one Metre of Specimen grammes.	Mean Load at Break. (Kilos.)	Mean Tensile Strength. (Kilos per unit gramme metre.
1	0.2856	9.9	34.6
2	0.3541	8 6	24.3
3	0.2717	6.4	23 5
4	0.2002	5 6	27.9
5	0.2833	8 2	28.9
6	0.2735	8 9	32.5
7	0.2413	6.2	25.6
8	0.2813	9.9	32.5
9	0.4080	13.0	31 8
10	0 3140	8.8	28 0
11	0.2499	6.1	24 4
12	0.2723	7.2	26.4
13	0.1866	6.7	35.9
14	0.2215	6.6	29.7
15	0.2280	5.3	23.2
16	0.2400	7.7	32.0
17	0.2400	6.4	26.6
18	0.2901	6.8	23.4
19	0.2960	8.5	21.7
20	0.3251	7.3	22.4
21	0.3003	9.3	30.9
22	0.2187	6.0	27.4
23	0.2085	6.6	31.6
24	0.2896	8.0	27.6
25	0.3120	7.3	23.4
26	0.2773	10.5	37.9
27	0.2960	9.0	3[illegible]4
28	0.2632	6.5	24.6
29	0.2187	7.5	34.2
30	0.3821	9.4	24.6

TABLE II.—(*contd.*)

Tensile Strength Determinations on Pineapple Fibre.—(contd.)

Specimen No.	Weight of one Metre of Specimen grammes.	Mean Load at Break (Kilos.)	Mean Tensile Strength. (Kilos) per unit gramme metre.
31	0 2845	8.6	30.2
32	0.2592	8 3	32.0
33	0.2720	8.7	32.0
34	0 3645	9.8	26.8
35	0.2912	7.8	26.7
36	0.2037	6.2	30.4
37	0.2509	7 2	28.6
38	0.1701	4.9	28.8
39	0.2866	8.5	29.6
40	0.2037	6.9	33.8
41	0.2880	7.7	26.7
42	0.2811	7.2	25.6
43	0.2784	8.2	29.4
44	0.2027	4.4	21.7
45	0.2757	9.4	34.0
46	0.2941	9.1	30.9
47	0.2698	8.7	32.2
48	0.2226	6.6	29.6
49	0 2720	6.5	23.9
50	0.2976	8.9	29.9

True mean of 50 terms = 28.58 Kilos per unit gramme metre.
Standard Deviation ±3.91

Each specimen consisted of 20 fibres. The Breaking Load was determined in two positions. The testing length, that is the distance between the fixed jaws of the machine at the commencement of the application of the load was 20 centimetres.

For comparison the mean Breaking Strengths of some other fibres are recorded in Table III. These figures were determined on the same machine in the precisely same manner.

TABLE III.

Comparative Tensile Strengths of Various Fibres.

Sample	Description.	No. of Specimens Tested.	Average weight of sample (Grammes)	Mean Breaking Loads (Kilos).	Mean Tensile strength (Kilos per unit gramme metre)	Standard Deviation of Tensile strength from Mean.
1	Manila Hemp "Extra Prime" Government Standard -	10	0.3929	18.0	46.1	± 5.1
2	Manila Hemp "Superior Current" Government Standard	10	0 517	20.1	40.05	6.8
3	Pineapple Fibre from canning pine leaves	50	0.2699	7.7	28.58	3.9
4	Manila Hemp from locally purchased imported Manila Hemp Cordage.	10	0 5784	13.2	23.38	4.9

The chemical characteristics of the fibre were determined on two lots of 100 grammes taken from the whole parcel of fibre. The procedure adopted is that described by Cross and Bevan and followed by the Imperial Institute. Results are recorded in Table IV together with some comparative results for Manila Hemp and Pineapple Fibre sent to the Imperial Institute from the Gold Coast.

TABLE IV.

Results of comparative Chemical Examination of Pineapple Fibre.

Sample.	Moisture.	Results calculated on the "Moisture-free" Sample.					
		Ash.	Loss on washing with water.	Loss on washing with acid.	Hydrolysis "A" Loss.	Hydrolysis "B" Loss.	Cellulose content.
	Per cent.	Per cent.	Per cent.	Per cent	Per cent.	Per cent.	Per cent.
Pineapple Fibre from canning pines grown at Klang -	9.7	0.8	0.9	2.2	11.7	17.0	79.0
Pineapple Fibre A. from canning pines grown at Serdang -	11.35	0 57	*nil*	1.01	12.17	18 18	81.70
Pineapple Fibre B. from canning pines grown at Serdang -	11.67	0.54	2 15	3 45	17.12	19 81	...
Pineapple Fibre C. From canning pines grown at Serdang -	11.32	1.2	...	...	14.69	17.87	83.09
Manila Hemp Grade A. "Extra Prime" from Dept Agriculture, Philippine Islands -	9 70	1.20	0.17	0.55	12 62	17.61	76 66
Pineapple Fibre from Gold Coast, Africa, Examined at Imperial Institute A.C. 153/25	9.5	1.1	...	1.07	13 7	19.14	81.5

OBSERVATIONS AND CONCLUSIONS.

From the figures recorded in Tables III and IV it is evident that the fibre prepared from the leaves of the fruiting pineapple plant of the "Singapore" variety possesses a comparatively high tensile strength and is a high grade fibre. The fibre is fine in staple and lustrous, with a soft silky texture. The investigations in connection with spinning and weaving are not yet complete but there is no doubt that the physical and chemical characteristics are sufficiently encouraging to warrant further trials.

With regard to the cost entailed in producing this fibre the size of the experiment precluded the detailed organisation necessary for economic working. Compared with a crop such as Sisal or Manila the cost of collection is high, because the pineapple leaves are small and the percentage of fibre is low. The 4 cwts. of fibre produced here necessitated the collection of approximately 20 tons of fresh leaves. This disadvantage is again apparent in the handling of the leaves in the factory. The comparative difficulty of obtaining a clean sample of fibre is another factor which would militate against a low cost of production and therefore we are of opinion that, although pineapple fibre can be obtained as a bye-product from the cultivation of canning pines, the present investigation does not indicate that it would be very profitable as a commercial enterprise.

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THE EFFECT OF TAPPING COCONUT PALMS FOR TODDY ON THE COPRA AND OIL PRODUCED FROM SUBSEQUENT FRUITING.

By H. W. Jack and J. H. Dennett.

Though it is well known that coconut palms which have been tapped for toddy are stimulated temporarily to produce heavy crops of fruit after the cessation of tapping, little is known of the duration of such stimulation or of its effect on the quality of the copra or its oil content.

Malays commonly affirm that the oil extracted from coconuts which have been collected from palms previously tapped for toddy makes a sweeter cooking oil than oil from coconuts collected from palms which have never been tapped, but that the meat from nuts from tapped palms contains less oil than meat from nuts of untapped palms. Moreover, they state that the meat in nuts collected from palms which have previously been tapped for toddy is thinner and less compact, and that they produce less copra per nut than nuts collected from untapped palms.

The commercial planter is not much concerned as to whether his copra contains a sweet cooking oil, but the question of the amount of copra he can obtain from his nuts is a significant factor in his costs of production and as such, warrants his attention. For this reason and in order to ascertain whether tapping for toddy really affected the quantity or the quality of the oil, the following experiment was conducted.

Through the courtesy of Mr. H. L. Carter, Manager of Dusun Durian Estate, 100 ripe coconuts gathered at random from palms which had never been tapped for toddy and 100 ripe nuts collected from adjacent trees which had previously been tapped for toddy, the tapping having been stopped two years prior to the time of collection, were obtained.

The palms from which both lots of nuts had been collected were planted at the same time and were growing in typical coastal alluvial loam under apparently similar conditions.

Records were carefully compiled from each lot of nuts (approximately 50 nuts being analysed in each case), and are shown in Tables A & B. From tables A & B the following averages per nut are extracted as expressed in Columns 1, 2 and 3 below, from which Columns 4 and 5 are calculated.

——	1. Wt. of Meat. grms.	2. Moisture on meat. per cent.	3. Oil on dry meat. per cent.	4. Wt. of dry meat (copra) in grms	5. Wt of oil per nut in grms.
Untapped palms	511	51.5	66.5	268.2	175.0
Tapped palms	490	49.5	63.2	242.5	153.3
Differences	21	2.0	3.3	20.6	21.7

These figures show that nuts from untapped palms contain 8.5 per cent more dry meat or copra and that the meat contains 14.2 per cent more oil than nuts obtained from palms which had been tapped for toddy two years prior to the time of collection of fruit. The increase, in the case of the copra, is insignificant, since the difference lies within the limits of the probable error (9.5 per cent) of the records, but the difference in the matter of oil content is of material import, since the increase is more than twice the probable error expressed as a percentage (6 per cent) of the mean oil content. Though the figures for copra production per nut do not definitely prove injurious effects resulting from tapping, they indicate fairly definitely a tendency in that direction which might have been accentuated had a larger number of nuts been treated in the experiment. Moreover, had the nuts been collected from tapped palms, after the lapse of a shorter interval of time than two years following the cessation of tapping, it is probable that the tendency to produce less copra per nut might have been emphasised materially.

It might be mentioned that the difference of approximately 21 grammes per nut would on an average plantation yielding 2,500 nuts per acre per annum result in a loss, by tapping for toddy, of 1 cwt. of copra per acre. At the same time it is likely that, under good conditions, the stimulation in nut production due to tapping might so increase the number of nuts per acre as to counterbalance the loss due to decrease of copra per nut. Unfortunately there are no available records to show how long the stimulation produced by tapping is continued, though the majority of experienced observers agree that it is only temporary, but it is clear that it would require several years of stimulated production to compensate for the year following the cessation of tapping, when nut production would be practically nil

The deficiency in oil content of copra derived from nuts collected from tapped palms is of no significance to the producer who markets his product as "copra" which is not bought by the manufacturers on any oil content basis (as far as the writers are aware) though preference in buying is given to producers in certain localities which have established a reputation for good well dried copra. Nevertheless, the manufacturer who buys copra obtained from tapped palms, loses approximately 22 grammes of oil per nut, or about 180 lbs. of oil for every ton of copra milled. This is equivalent to a loss to the manufacturer of about £3.10.0 on every ton of copra milled, assuming the price of coconut oil to be £40 per ton.

Fortunately the number of bearing palms used for toddy tapping is only a small percentage of the total number of palms grown for copra production, at least in Malaya, so that the commercial product is little affected by the mixture of copra from tapped palms.

The Determination of the Oil Content.

The nuts were opened and the various parts weighed as soon after arrival as possible and an average sample of the meat from each

nut (in the form of thin slices taken through the meat) was dried in the steam oven to obtain the moisture content.

This dried sample was used for the determination of the oil content. The oil was extracted with chloroform, and the following constants were determined from average samples.

CONSTANTS.

—	Refractive Index at 28.5°C	Iodine Value per cent.	Saponification Value (m. grms. K O H per 1 gram oil.)
Tapped	1.4535	6.6	261
Untapped	1.4538	5.7	267
Lewkowitsch's figures for pressed coconut oil.	1.441 C 60°C.	8.0-9.5	257.3-268.4

The physical constants for the oils obtained from both tapped and untapped palms show no significant differences.

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TABLE A.—UNTAPPED PALMS.

Weight of Nuts.	Weight of Shell.	Shell.	Weight of Meat.	Meat.	Volume of Milk.	Milk.	Oil on Nut.	Moisture on Meat.	Oil on Meat.	Moisture + Oil on Meat.	Oil on dry Meat.
(Grms.)	(Grms.)	(per cent).	(Grms.)	(per cent.)	(c.c.s.)	(per cent.)	(per cent.)	(per cent.)	(per cent.)	(per cent.)	(per cent.)
1467	330	22.4	607	41.4	530	36.2	11.6	57.6	28.0	85.6	60.5
1360	257	19.0	575	42.3	530	39.0	11.7	54.6	27.8	82.4	61.5
1555	325	20.8	540	34.8	690	44.4	16.2	53.5	26.5	80.0	58.0
1580	320	20.2	650	41.2	630	39.5	11.9	54.7	29.4	84.1	64.0
950	325	34.2	455	48.0	270	28.4	13.3	39.4	27.9	67.3	46.2
1025	330	32.2	465	45.4	330	32.2	16.2	44.5	35.8	80.3	64.5
1080	225	20.8	520	48.2	270	25.0	17.0	51.0	33.4	84.4	68.0
1280	260	20.3	510	39.8	510	39.5	11.0	53.5	27.9	81.4	60.0
1310	290	22.2	570	43.5	450	34.4	11.7	56.6	27.4	84.0	62.5
970	240	24.7	445	45.8	285	29.5	9.5	62.8	20.7	83.5	55.5
1340	280	20.8	550	41.1	505	37.6	15.1	44.3	29.1	73.4	65.7
1090	250	23.0	410	38.7	410	37.7	11.4	50.6	30.3	80.9	61.5
1480	330	22.0	620	41.9	530	35.8	12.3	52.7	19.8	82.5	61.0
1010	220	21.5	440	43.5	350	23.6	17.7	42.4	41.0	83.4	71.0
1400	250	17.8	660	47.0	590	42.2	7.8	69.3	16.7	86.0	54.3
1710	325	19.0	630	36.8	755	44.1	9.7	51.8	26.4	78.2	54.7
1120	260	23.2	450	40.5	410	36.8	12.5	51.9	31.2	83.1	64.7
1080	270	25.0	440	40.7	350	32.4	13.1	48.0	33.5	81.5	64.5
1030	240	23.4	470	45.5	320	31.3	13.7	51.5	29.2	80.7	60.4
1090	240	22.0	500	46.0	350	32.1	10.8	61.8	22.1	83.9	58.0
1230	250	20.3	530	43.0	450	36.6	13.6	51.3	31.9	83.2	65.5
1000	200	20.0	500	50.0	300	35.0	16.0	489	31.9	80.8	62.5
1250	260	20.7	510	40.8	380	30.4	11.4	55.3	28.0	83.3	62.7
990	280	28.5	510	51.5	200	29.2	10.2	63.9	19.1	83.0	53.0

TABLE A.—Untapped Palms.—(*contd.*)

Weight of Nuts. (Grms.)	Weight of Shell. (Grms.)	Shell. (per cent.)	Weight of Meat. (Grms.)	Meat. (per cent.)	Volume of Milk. (c.c.s.)	Milk. per cent	Oil on Nut. (per cent.)	Moisture on Meat. (per cent.)	Oil on Meat. (per cent.)	Moisture + oil on Meat. (per cent.)	Oil on dry Meat. (per cent.)
1300	250	19.2	550	42.5	450	34.6	14.7	49.0	34.6	83.6	67.8
1320	280	22.0	540	40.9	500	37.9	13.0	52.8	31.8	84.6	67.5
1580	300	19.2	680	42.7	600	38.0	13.9	50.4	32.2	82.6	65.0
1080	240	22.5	460	42.6	380	35.2	13.3	48.8	31.2	80.0	60.9
1220	270	22.2	500	41.0	450	36.7	13.3	48.9	32.4	81.3	63.5
1270	260	20.4	570	44.8	440	34.7	17.1	41.3	38.0	79.3	64.7
1120	260	23.2	500	44.7	360	32.2	18.4	42.7	41.1	83.8	71.8
1200	250	20.7	550	45.7	400	33.5	16.4	51.8	35.8	87.6	74.3
920	200	21.7	420	45.6	300	36.4	18.0	44.8	36.1	80.9	65.5
930	240	23.6	370	39.8	320	36.8	15.4	46.6	36.0	82.6	67.5
1610	350	21.6	580	39.0	680	42.0	10.5	47.2	29.1	76.3	55.2
970	240	26.5	420	44.5	310	33.0	9.9	59.8	22.1	81.9	55.0
1200	250	20.8	550	46.0	400	33.3	14.3	51.8	31.3	83.1	64.7
920	200	23.6	420	49.7	300	35.5	17.9	44.8	35.7	80.5	64.6
930	240	27.8	370	42.7	320	37.2	15.3	46.5	35.5	82.0	66.5
1450	320	22.0	600	41.5	530	36.5	11.2	52.7	27.1	79.8	57.2
1020	240	23.5	470	46.0	310	29.7	15.7	45.8	34.1	79.9	63.2
1040	230	22.2	490	47.0	300	28.8	15.8	50.5	33.6	84.1	67.9
1630	300	18.4	700	43.0	630	38.6	12.1	58.4	28.0	86.4	67.3
950	200	22.3	400	44.4	350	38.8	14.3	50.5	32.1	82.6	64.8
1390	300	21.6	640	46.1	450	32.4	10.3	54.5	22.3	76.8	48.9
1170	230	19.7	480	41.2	460	39.3	13.0	49.0	21.6	80.6	62.0
1185	265	23.2	511	43.1	42.7	36.2	13.8	51.5	32.5	84.0	66.5

TABLE B.—TAPPED PALMS.

Weight of Nuts. (Grms.)	Weight of Shell. (Grms.)	Shell. (per cent.)	Weight of Meat. (Grms.)	Meat. (per cent.)	Volume of Milk. (c.c.s.)	Milk. (per cent.)	Oil on Nut. (per cent.)	Moisture on Meat. (per cent.)	Oil on Meat. (per cent.)	Moisture + Oil on Meat. (per cent.)	Oil on dry Meat. (per cent.
1492	247	12.6	635	42.5	610	38.4	13.9	48.3	32.5	80.8	63.0
1042	212	19.4	480	46.0	350	33.5	15.4	48.7	33.4	82.1	68.0
1146	226	18.8	520	46.6	400	35.0	12.0	55.0	26.5	81.5	62.3
1244	250	20.2	544	42.8	450	36.1	11.4	53.7	26.2	79.9	62.5
1069	222	19.6	487	45.5	360	33.8	17.6	45.0	35.6	80.6	64.9
1090	205	18.8	555	50.9	330	30.4	17.6	46.5	34.7	81.2	45.0
860	180	20.8	425	49.5	255	29.2	15.4	51.6	31.0	82.6	64.0
1374	312	22.5	682	49.6	460	33.5	11.7	55.0	26.8	81.8	59.8
1065	225	21.2	470	44.2	370	34.8	12.9	62.8	29.4	92.4	80.0
1140	240	21.0	520	45.6	340	29.8	17.3	41.9	37.8	79.7	65.1
1020	230	22.5	430	42.3	360	36.2	15.6	44.3	37.1	81.4	66.6
1010	230	22.7	420	41.5	360	36.4	11.1	54.6	26.8	81.4	59.5
1300	320	24.6	560	43.0	420	32.4	12.7	55.4	29.4	84.8	66.0
980	220	22.2	420	42.8	340	34.8	13.5	49.4	31.1	80.5	62.3
960	210	20.7	470	49.0	280	29.2	18.7	45.5	38.3	83.8	69.9
1040	230	22.0	510	49.0	300	28.8	14.7	50.0	30.1	80.1	60.0
755	165	21.9	405	53.5	185	24.5	15.1	43.5	33.1	76.6	58.5
1110	240	21.6	470	42.4	360	32.5	12.7	50.6	30.2	80.8	60.7
1290	280	22.5	610	47.4	600	46.5	14.6	49.9	31.7	81.6	63.3
1055	280	26.6	430	40.7	240	22.8	12.1	47.8	32.5	80.3	62.3
1010	240	24.0	440	42.4	330	30.2	14.3	45.1	32.5	77.6	59.4
1210	270	22.3	570	47.1	360	29.8	16.4	49.3	34.5	83.8	68.0
1140	240	19.4	580	50.8	380	33.5	16.5	39.2	31.8	71.0	52.2
960	200	20.8	440	45.8	320	34.4	14.9	51.8	31.3	83.1	64.9
1450	350	24.1	500	34.5	600	41.4	10.5	51.2	30.4	81.6	62.5
1190	250	21.0	590	49.6	350	29.5	13.3	53.7	26.7	80.4	57.7
1100	230	20.8	500	47.8	370	33.5	13.3	49.5	29.2	78.4	57.9
880	200	22.4	400	45.5	280	31.9	16.5	51.2	30.2	81.4	70.6

TABLE B.—TAPPED PALMS.—(*contd.*)

Weight of Nuts. (Grms.)	Weight of Shell. (Grms.)	Shell. (per cent.)	Weight of Meat. (Grms.)	Meat. (per cent.)	Volume of Milk. (c.c.s)	Milk. (per cent.)	Oil on Nut. (per cent.)	Moisture on Meat. (per cent.)	Oil on Meat. (per cent.)	Moisture + Oil on Meat. (per cent.)	Oil on dry Meat. (per cent.)
1390	250	18.0	580	41.7	560	40.3	14.4	55.5	34.4	89.9	77.2
1090	220	19.4	480	44.0	390	35.8	11.1	57.1	25.3	82.4	59.0
1175	270	23.1	480	40.8	425	36.1	13.4	44.5	32.3	76.8	58.2
1110	220	20.7	510	46.0	380	35.8	14.3	50.9	31.2	82.1	63.6
1160	250	21.6	500	43.0	410	35.4	13.4	48.9	31.3	80.2	61.2
990	210	21.2	450	45.5	330	33.7	13.3	51.6	29.2	80.8	60.3
1020	200	19.8	490	48.0	320	31.5	14.3	57.6	29.8	87.4	70.2
1420	300	21.1	620	43.6	500	35.3	11.9	53.3	27.2	80.5	58.2
1060	240	22.6	470	44.4	350	33.0	13.3	49.1	30.2	79.9	59.3
1000	270	27.0	430	43.0	300	30.0	13.8	49.7	34.0	83.7	67.5
1400	340	24.3	620	44.2	370	26.5	14.2	51.8	31.8	83.6	65.9
1230	280	22.7	570	45.6	380	30.9	17.1	41.4	35.6	77.0	60.7
1000	240	24.0	440	44.0	320	32.0	15.2	50.6	34.5	85.1	69.8
1400	340	24.2	580	41.5	480	34.3	9.7	55.1	23.5	78.6	52.8
1040	270	25.8	450	43.4	320	30.8	12.7	50.2	28.1	78.3	56.4
1010	240	23.7	500	49.5	270	27.0	18.3	44.1	36.9	81.0	66.0
1150	260	22.6	480	41.7	160	13.9	18.7	37.0	44.6	81.6	70.8
1060	240	22.6	450	42.4	370	35.0	12.8	52.8	30.2	83.0	64.0
1030	250	24.3	460	44.5	320	31.0	15.6	45.9	35.0	80.9	64.7
1060	260	24.5	460	43.2	320	30.2	12.6	51.0	28.8	79.9	58.7
1370	330	24.2	580	42.3	460	33.6	12.9	50.5	30.5	81.0	61.6
920	180	21.2	450	53.2	270	32.0	16.9	48.5	31.6	80.1	61.3
1050	250	23.7	330	31.5	470	44.5	11.5	42.5	36.5	79.0	63.4
940	200	22.7	440	50.0	300	34.0	14.4	46.0	28.9	74.9	53.5
1160	240	20.5	540	46.6	380	32.7	17.1	49.9	36.6	86.5	73.0
1116	241	21.5	490	43.9	364	32.5	14.1	49.5	32.0	81.5	63.2

SAPUCAIA NUTS.

By W. N. Sands.

BESIDES the Para Rubber tree (*Hevea brasiliensis, Mull.*) two other important South American trees have been successfully introduced to cultivation in Malaya in recent years; these are the Brazil Nut (*Bertholletia nobilis, Miers.*) and one of the Souari or Piqui'a Nuts (*Caryocar villosum, Pers.*) In view of the gratifying results which have followed these introductions, efforts are being made by the Department of Agriculture to obtain from Brazil another highly-prized nut, namely the Sapucaia Nut which is derived from a species of *Lecythis.* It is said that this nut is superior to the Brazil Nut in flavour and quality. It would appear that the Sapucaia Nut exported from Brazil is derived from *Lecythis usitata, Miers*, although other species of the same genus, e.g., *L. Zabucayo, Aubl.*; *L. lanceolata, Poir.*, and *L. Pisonis, Camb.*, are also known to produce edible nuts.

Miers[1], writing in 1875, states that "the seeds of a species of *Lecythis* abundant in the Province of Para are exported to Europe in considerable quantities and sold there in the shops as Sapucaia Nuts," and again that "*L. usitata* is the species which produces the well-known Sapucaia Nuts of commerce; and it is very different from *L. Zabucayo, Aubl.*" At the present time, however, the chief exports appear to go to the United States of America, for in a letter dated 27th October 1923, received from the Assistant Director of the Royal Botanic Gardens, Kew, it is stated that "owing to the lack of demand for the nut in this country the whole of last season's stock was exported to America."

Mr. L. A. Emerson, late of Tembeling, Pahang, who resided for some time in Brazil, has been good enough to supply the following interesting information concerning the nut derived no doubt from *Lecythis usitata, Miers.*

"The tree is indigenous to the tropical rain-forests or "Selvas" of North Brazil; but is also found in the Republics of Peru, Colombia, and Venezuela, in the districts which border Brazil.

"The chief export is from the Amazon River via the Port of Santa Maria de Belem do Para.

"This nut fetches a much higher price on the European markets than does the "Castanha" or Brazil Nut (*Bertholletia excelsa*) owing to its superior flavour for one thing, but chiefly due to the difficulty of collection.

"Sapucaya nuts are contained in a large, heavy, woody pot-shaped receptacle, closed by a natural lid. Monkeys twist the fruit off the tree; the impact of the fall forces off the lid, and the seeds or

nuts are scattered. As the "shell" of the nut itself is comparatively soft, peccaries, monkeys, and the large rodents peculiar to South America, soon devour the scattered seed, and that which escapes the Fauna, quickly germinates or rots on the damp leaf-mould of the forest-floor.

" Whereas of course the Brazil-nut, with its immensely strong woody seed-pod, can lie on the ground for months, and nothing can get at the nuts inside. In fact the pod has to be broken with sledge hammers before the nuts can be shipped.

" Another reason for its higher market price is that Brazil consumes a considerable quantity herself, which is not the case with the Brazil-nut which is collected almost entirely for export.

" Like the Brazil-nut, the Sapucaya contains a considerable quantity of natural oil. The Brazilians believe this oil has medicinal properties ; and the Incas of Peru—according to the Spanish Archives—are said to have expressed the oil in crude presses for use as a drug.

" Owing to its soft shell, I should imagine that the transport and storage in bulk of Sapucaya nuts was a much more difficult problem than Brazil-nuts.

" The seed-pod is a large, heavy, woody, pot-shaped receptacle which may contain 20 to 30 nuts.

" The nuts are packed loosely inside the pod. The stem of the fruit is at the opposite end to the " lid" of the receptacle.

" The lid is circular, its inner edge being bevelled to fit the correspondingly bevelled edge of the pot-rim.

" The walls of the receptacle vary from ½" to ¾" in thickness, and are of a hard cinammon-coloured wood. The shape is invariably symmetrical.

" The tree grows in the same forest areas as the Brazil nut, but is not nearly so plentiful due to the afore-mentioned causes.

" The seed or nut is oblong in shape and about 2" long. The skin or shell is of a cinammon colour, and grooved something like an English peach-stone, but more symmetrically. When fresh the shell can be removed with the thumb-nail, exposing the white kernel beneath. The flavour of the fresh seed has a slight resemblance to that of the Kentish " Cob" Nut ; but is of course more oleaginous than the latter. The shell or skin of the seed is about 1 mm. in thickness.

" With regard to the alleged medicinal properties of the oil obtained from the nut, foreign and Brazilian doctors have told me they think that there is little in this."

Of other species producing edible nuts little information has been obtained so far. Miers (loc: cit) mentions that *Lecythis Zabucayo, Aubl.*, was introduced into Mauritius from Cayenne by the Comte D'Estaing who, during a visit to Cayenne in 1758, was so delighted with the seeds of the Zabucayo that he carried away with him twelve living plants of the tree and planted them in the garden at Reduit. Another species, *L. lanceolata, Poir.*, which is known as Sapucaia blanca, is found in Guiana. According to Rodrigues[2] it yields seeds which are eaten either boiled or raw and which are considered narcotic. With the paste extracted from the seeds, emulsions are prepared which are used as a remedy against affectations of the urinary canal. He also states that *L Pisonis Camb.*, also known as Sapucaia in Brazil, produces seed which are eaten either raw or roasted.

All of the species named are large jungle trees of the tropical rain forests of South America, and there appears to be no reason why they should not thrive in Malaya as well as the other valuable ones mentioned at the commencement of this article.[2]

REFERENCES.

1. Miers, J.—On the Lecythidaceae, Trans. Linn. Society. Vol. XXX, pp. 157-318 (1875).

2. Rodrigues, J. B —Hortus Fluminensis on Breve Noticia Sobre Plantas Cultivados no Jardin Botanico Do Rio de Janeiro. Jan: 1894.

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NOTE.

Calopogonium mucunoides is usually stated to be intolerent of shade and useless as a cover plant for old rubber areas.(1)

In this connection it is of interest to report that on Bukit Kiara Estate, Kuala Lumpur, this legume has been grown since 31.1.25 as a cover crop on a small scale, amongst rubber trees planted in the year 1913. The trees are spaced 15' by 15' and provide moderate shade over the land. The soil is a light sandy loam. Previous to broadcasting the Calopogonium seed the surface soil was slightly stirred and a small application of cattle manure applied.

I inspected this cover crop on the 4th of September, 1925, and found the plant thriving and giving a satisfactory cover. The crop was seeding at the time of my visit.

F. G. S.
4-9-25.

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(1) Calopogonium mucunoides. Malayan Agricultural Journal, Vol. XIII. No. 8, August 1925, page 271

(2) Since writing the above the writer learns that a small supply of the nuts for planting has been received by a local estate.

W. N. S.

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture: and the Malay States Information Agency, 88, Cannon Street, E.C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV	(1913-16) VIII & IX (1920-21)		price	$5.00 per volume.
Vol. V	(1917)	Nos. 1, 2, 3, 5 & 6	„	2.50 per set.
„ VI	(1918)	„ 1, 7, 8 & 12	„	2.00 „
„ VII	(1919)	„ 2—6	„	4.50 „

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

Vol. X (1922)	Price $5.00 per volume.
„ XI (1923)	Price $5.00 per volume or 50 cents per single number.
„ XII (1924)	„ „ „ „

Back numbers of Vols. I—X will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased at the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co.

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, Government Entomologist, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher.
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, Government Entomologist, 1910, reprint 1916, 20 cts. (Out of Print.)
4. A Lepidopterous Pest of Coconuts, *Brachartona catoxantha, Hamps*, by H. C. Pratt, 1909.
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909.
6. Preliminary note on a Branch and Stem Disease of *Hevea Brasilienisis*, by W. J. Gallagher, 1909.
7. Coffea Robusta, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910.
9. Die-Back Fungus of Para Rubber and of Cacao, by K. Bancroft, 1911.
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher, 1910.
11. Coconut Cultivation, by L. C. Brown, 1911.
12. Padi Cultivation in Krian, by H. C. Pratt, 1911.
13. A Root Disease of Para Rubber, *Fomes Semitostus*, by K. Bancroft, Assistant Mycologist 1912, 20 cts.

C = Cancelled

THE

Malayan Agricultural Journal.

Vol. VIII.] Oct., 1925. [No. 10.

INVESTIGATIONS ON "TUBA".

By B. A. R. Gater.

Introduction.

It is with some considerable hesitation that the following paper is published owing to the inconclusive nature of many of the results. So many enquiries are being received on the subject of "tuba" or "toeba", and so many misapprehensions about it seem to exist, that the records obtained in this laboratory were considered to be worth while publishing even at the risk of making public more or less "half-baked" results. Moreover the investigations on the toxicity of the various plants have gone as far as they can under existing conditions in this laboratory, and the results obtained, being of some practical use, may interest planters.

As an insecticide, derris, which is the substance to which the name "tuba" is usually applied, is not the wonderful insecticide which is sometimes imagined. It is a good insecticide for certain purposes, and except that it is not a volatile poison may be compared to nicotine in efficiency. Nicotine is largely used in horticulture, and it is probable that derris will replace this rather expensive substance to a great extent. Derris will not, on the other hand, replace the arsenical insecticides, which have entirely different properties. Although it is both a contact and a stomach poison, its practical use will to a large extent be limited to the former class. Nevertheless it is a most convenient substance for use on estates in this country, where a little can be grown and is always at hand when required, and this practice will probably be followed more widely in the future. On the other hand, as far as its growth for export is concerned, it should be mentioned that the trend of modern knowledge on insecticides is towards the use of chemical as opposed to plant-products, and the former will always be produced more cheaply than the latter, especially if they are in the nature of by-products of other industries. Thus quite recently it has been found that certain fluorine compounds are of high insecticidal value, and of these, sodium fluosilicate is considered to be superior in many ways to the arsenicals. This substance is a by-product in the manufacture of acid phosphate, and is less than half the price of calcium arsenate (S. Marcovitch, Univ. of Tennessee, Agric. Expt. Sta. Bull. 131),

Against substances of similar insecticidal value which are by-products of a chemical industry no plant-product can hope to compare in price.

Regarding the "non-poisonous" nature of derris, the term is merely comparative. Although not to be compared with the arsenicals or nicotine in toxicity to the higher animals, it is nevertheless toxic, and should not be handled carelessly. Derris is also used by certain tribes as an abortifacient.

As an insecticide there are roughly three ways of applying derris, viz:—as a water 'extract' in the form of a spray, as a dust, and as a spray made by emulsifying with water an extract obtained by chemical means. The chemical extracts have not been used largely up to the present time owing to difficulties in extraction and the expense of the solvents used. Methods have lately been perfected, however, and we may expect to see concentrated extracts more widely used. The dust is not easy to obtain, and requires special machinery for its manufacture, but is efficient and easily applied. On estates which grow derris the water 'extract' is still the most convenient form of application, and the following is the method of preparation which has been found efficient in this country:—

Derris roots	-	2—4 lbs
Soap	-	2 lbs
Water	-	10 galls.
To be diluted at the rate of		1 in 10.

The derris is cut into small pieces and thoroughly pounded to a pulp. If a stone mortar or similar appliance is available a little water may be added to facilitate pounding. Five gallons of water are placed in a barrel or wooden tub and the derris pulp is enclosed in a cloth and steeped in the water, any "extract" which remains from the pounding being added.

The soap is sliced and dissolved in 5 gallons of water, using heat if necessary. When the soap has dissolved, the solution is put aside to cool, and the derris pulp is thoroughly squeezed until all the milky juice has been 'extracted.' The soap solution is now mixed with the milky fluid obtained from the derris, and the stock solution diluted at the rate of 1 in 10 of water. Iron containers should not be used.

This spray will be found useful for general purposes, but for small soft-bodied insects less derris may be used. The actual amount necessary will depend to a certain extent upon the efficiency with which it is pounded and squeezed. The spray will not keep for more than two days without losing its efficiency

The following remarks are divided into two parts, the first dealing with toxicities of various plants which go under the collective name of "tuba," while the second deals with the insect pests on

Derris spp. as far as they are at present known. It is convenient to give a short summary here :—

1. The Malay word "Tuba" is not confined to species of *Derris*.
2. Eleven "tuba" plants not *Derris* sp. were found to have no practical value as insecticides.
3. The species of *Derris* vary in toxicity, as do apparently varieties of the same species.
4. *Derris elliptica* variety "Tuba rimba" appeared to be the best plant for use on estates.
5. Notes are given on 11 insects which feed on the leaves of derris, and a serious pest on the stored roots is mentioned.

PART I.

THE INSECTICIDAL VALUE OF MALAYAN PISCICIDES.

The natives of Malaya, especially the Sakai or aboriginal tribes, have long been versed in the art of utilising various plants as poisons in the pursuit of food. Numerous arrow-poisons are known, with which it is possible to bring down heavy game, but in addition to these certain plants are used for poisoning fish in rivers and streams. The plant used is pounded and thrown into the river, the fish rising to the surface in a dead or stupefied condition, where they are caught by a line of men drawn across the stream Although now generally prohibited on account of the enormous waste of life, fish drives, as they are called, still form part of the entertainment given by native chiefs on fête-days.

The commonest substance used for poisoning fish is the pounded roots of the plant kown in Malay as "tuba", the plant most frequently referred to under this name being a species of *Derris* of the order Leguminosæ. Derris is now quite a well-known insecticide, having been used for a long time by Chinese market gardeners, and more recently as the principal constituent of various proprietary insecticides. Considerable work has been done on both the chemistry and toxicity of the substances contained in this plant by numerous investigators, among whom may be mentioned Greshoff, Power, Sillevoldt, Ishikawa, Mc. Indoo and others, Tattersfield, Roach, Fryer and Stenton * Nearly all these investigators, however, confined their researches to one species, *Derris elliptica*.

On enquiry among Malays it was found that there was a large number of plants in this country which, although called "tuba" in the vernacular, were not the same, and could not always be referred to the genus *Derris*; and that the word "tuba" even extended, in some parts of the Peninsula, to inorganic poisons such as arsenic, which has been called "tuba tikus" (rat poison).

* For papers by the last four investigators, and a bibliography, see "Annals of Applied Biology," Vol. X, No. 1.

It was therefore decided that it would be advisable to make a collection of all the "tuba" plants which could be obtained, and to test their insecticidal properties, and at every opportunity specimens of "tuba" were obtained from the natives and kept in the entomological laboratory for examination.

For the sake of simplicty the plants obtained were divided into two groups, the *Derris* species and the non-*Derris* species, and this division is adherred to in the present paper. From the start, however, it was obvious that there would be great difficulty in identifying the material, and it was not until the beginning of the present year that it was possible to get even a portion of the material named. Most of the non-*Derris* plants were obtainable only as roots, bark or other portions, and in the case of the *Derris* species the roots only were generally sent in. Owing to the kindness of I.H. Burkill, Director of the Botanical Gardens, Singapore, a portion of the material was eventually identified, and the author's thanks are due to him for the trouble he took in identifying a very unpromising number of specimens.

The results given in the present paper are preliminary, and much more work will have to be done before the conclusions arrived at can be set down as accurate Especially is this so in regard to the comparative toxicities which must be tested on a larger number of insects of different species.

NON-DERRIS SPECIES.

Through the generosity of W. H. Barnes and G. E. Mann, Agricultural Field Officers for Negri Sembilan and Selangor, a collection of plants was obtained from the Sakai in their areas. Not all of them have been identified, as will be seen from the following table :—

TABLE I.

Natural Order.	Name.	Vernacular.
Menispermaceae	*Coscinium Blumeanum*, Miers	Tuba kupak.
Guttiferae	*Calophyllum ? spectabile*, Willd.	Kulit bentangor.
Guttiferae	*Calophyllum ? spectabile*, Willd.	Akar bentangor.
Myrtaceae	*Barringtonia speciosa*, Forst.	Putat.
Ebenaceae	*Diospyros Wallichii*, King and Gamble	Tuba buah-daun.
,,	*Diospyros Wallichii*, King and Gamble	,, ,, -akar.
Styraceae	*Styrax benzoin*, Dry.	Kemenyan.
Dioscoreaceae	*Dioscorea piscatorum*, Prain and Burkill	Tuba cherok.
...	Unidentified	Tuba janirok.
...	,,	,, tapah.
...	,,	,, hantu.
...	,,	,, sasan.
...	,,	,, riam.

Since all the plants are simply pounded and thrown into the stream for poisoning fish it is evident that water must be able to extract the toxic substances. For testing the insecticidal values of the plants a water extract was made by chopping up a quantity of the plant as fine as possible and then pounding a weighed quantity in a mortar with a little water, until a pulp had been obtained. This was then strained through muslin and the remaining pulp well squeezed out in the water. The liquid samples thus obtained were then made up to equal volumes with water.

Coscinium Blumeanum.—This is a climbing plant which is usually found on flat land and in secondary jungle growth, and its long yellow tubers are eaten by the Sakai. It is, in fact, usually found in abandoned Sakai clearings in the jungle. The bark is used as a fish-poison in the usual way, i.e. pounding and throwing it into the stream. The bark and stems were hard and yellow in colour, and were difficult to cut up and pound. With water a light 'curry powder' coloured liquid was obtained which was slightly frothy, and had a tendency to stain the muslin yellow.

Calophyllum spectabile.—A jungle tree which provides a first-class timber, found on hilly and flat ground and in swamps. The Sakai say there are many varieties of 'Bentangor' so that the specific identity is doubtful. The bark of the trunk and roots is used.

(*a*) Bark. Easily pounded, giving a reddish yellow liquid.

(*b*) Root bark. Difficult to pound and gives a coloured liquid which is similar to that obtained from the trunk but lighter.

Barringtonia speciosa.—This tree grows to a girth of four feet on dry flat land only, and is planted as an ornament. The bark was not very easily turned to pulp, and gave a light brown liquid.

Diospyros Wallichii.—Timber can be obtained from this tree, which grows to a girth of about four feet on hilly land, but the timber is not used. The bark of the trunk and the leaves are employed.

(*a*) Leaf. Easily pounded, giving a dark green fluid, probably mostly chlorophyl. The liquid has a faintly aromatic smell.

(*b*) Bark. Fairly easily pounded, giving a coffee-coloured fluid which shows no tendency to froth, even when soap is added.

Styrax benzoin.—This tree is found on hilly land and is tapped by the Malays who use the resin as an incense on various ceremonial occasions. The bark as well as the roots are apparently used as a fish-poison. The wood is light red in colour; difficult to reduce to a pulp; gives a frothy, reddish liquid.

Dioscorea piscatorum.—This is a newly described species of *Dioscorea*, and has been proved to be toxic to fish by Burkill and

Holttum.* The tubers are easily pounded and give a red liquid which is distinctly frothy.

Tuba janirok.—Similar to tuba hantu, fairly easy to pound. A stronger aromatic smell than tuba hantu, similar to gum benzoin.

Tubah tapah.—This and the following plants have not been identified and were received as roots only The roots suggest the fibrous qualities of *Derris* but it is impossible to say what they are. Fairly easy to pound, giving a light coffee-coloured liquid.

Tuba hantu.—Fairly easily pounded, colour of liquid similar to tuba tapah. Faint aromatic smell.

Tuba sasan.—Dark coffee-coloured liquid obtained. Root fairly easy to pound.

Tuba riam.—Fairly easily pounded, light yellow translucent fluid.

For trials of the insecticidal value of these plants 5 grms of the chopped samples were well pounded in a mortar, the pulp squeezed and strained through muslin, and the liquid made up to 100 cc. with water. At the first trial, although some showed evidences of being toxic to insects only two showed any promise, viz: *Dioscorea piscatorum* and Tuba janirok. The fact that all these plants are used as fish poisons does not necessarily mean that they will be toxic to insects, and it is possible that not all of them are toxic to fish. No opportunity of testing this point was forthcoming, but it is well known that a number of quite innocuous plants is included in the various poisons made by the Sakai on account of the ritual which accompanies their manufacture, and it is quite possible that some of the above plants are included in fish-poisons with, say, a species of *Derris* from which the real toxic substance is derived. On the other hand it might be found that the fresh plants held toxic principles which so changed their constitution on drying that their toxicity is lost In addition it is possible that some of the last four may be species of *Derris* which are non-toxic. The water extracts, however, showed none of the characteristic appearance and smell of the known species of *Derris* which have been tested.

It was considered that none of the plants would be of importance unless they exhibited a toxity at least equal to a commonly grown *Derris*, and a variety of D. *elliptica* (Tuba rimba) which is grown on a large scale, was used as a basis of comparison in the tests. Sodium oleate was used at the rate of 0.25 per cent to act as a wetting agent in all the experiments, the required quantity being added in solution to the water extracts. Throughout the tests the mature larvae of *Parasa herbifera*, Walk. (Limacodidae) were used, ten larvae being employed for each test. By means of a brass wire gauze cage they were totally immersed in the liquid for half a minute, being caged with their food plant directly afterwards. They were handled by means of clean camel-hair brushes. The results are shown in Table II.

*The Gardens' Bulletin, Straits Settlements, Vol. III Nos. 7-8. p. 260.

TABLE II.

Non-Derris Species.

D = Dead. C = "Comatose". A = Alive P = Pupated.

Plant used.	Strength % of root, etc.	Results.										
		After 2 hrs.			After 24 hrs.				After 48 hrs.			
		D.	C.	A.	D.	C.	A.	P.	D.	C.	A.	P.
Coscinium Blumeanum ...	5		1	6			6	4			5	5
	2.5			10			10				10	
Calophyllum ? spectabile (bark)	5			10			10				8	2
	2.5			10			10				10	
Calophyllum ? spectabile (root)	5			10	2		8		2		6	2
	2.5			10		1	9		1		7	2
Barringtonia speciosa ...	5			10			8	2	2		2	6
	2.5			10			10				7	3
Diospyros Wallichii (leaf)	5			10	2		6	2	2		2	6
	2.5			10			9	1			5	5
Diospyros Wallichii (root)	5		2	8			10				6	4
Styrax benzoin ..	5			10	2	2	2	1	6			4
	2.5			10		1	7	2	1		3	6
Dioscorea piscatorum ...	5		6	4	6	1			8			2
	2.5		1	9	1		8	1	2		6	5
	.5			10			10				10	
Tubah tapah ...	5			10			8	2			4	6
Tuba bantu ...	5		4	6		2	8		4		2	4
	2.5			10			8	2			5	5
Tuba sasan ...	5		2	8	2		6	2	2		4	4
	2.5			10			7	3			7	3
Tuba janirok ...	5		8	2	10				10			
	2.5		1	9		1	6	3	1		3	6
	.5			10			9	1			6	4
Tuba riam ..	5			10			8	2			2	8
Derris elliptica ...	5	10			10				10			
Control ...	2.5	10			10				10			
	.5	10			10				10			
Sodium oleate ...	.25			10			10				10	
Control ...	.25			10			4	6			8	2
	.25			10			7	3			2	7

The pupations recorded are considered to have been accelerated slightly by the immersion in the various fluids. It was difficult at times to decide whether the "comatose" state was due to approaching pupation or to the action of the fluid, and in some cases the comatose indivivuals merely pupated and emerged normally later on. The normal time of pupation, according to the breeding records for the batch of larvae used, would have been from three to four days after immersion, and although the date cannot accurately be forecasted for individual larvae in a large batch, it is thought that premature pupation as a result of treatment took place to a certain extent. All larvae which pupated completed their development and emerged, some of the moths being a little undersized. This last is not considered to have much significance, however, since there is some variation in this species in nature.

It will be seen that although some toxicity is shown by several of these plants, it does not compare with that shown by *Derris*, especially on dilution. It is thus concluded that none of the plants tested will become of any practical use as an insecticide.

Derris Species.

According to Ridley (Flora of the Malay Peninsula, Vol. I) there are eleven species of *Derris* in this country, viz:—

Name.	Habitat.	Distribution.
Derris sinuata, Thw.	- Tidal rivers	- India, Ceylon, Indo-China, Malaya.
Derris thyrsiflora, Benth.	- Open country	- Sumatra, Java, Malaya.
Derris scandens, Benth	- Woods near sea	- Indo-Malaya, Australia.
Derris dalbergioides, Baker.	- Open country	- Tenasserim, Malaya.
Derris uliginosa, Benth.	- Mangrove swamps	- East Africa, Malaya, Mascarenes
Derris elegans, Benth.	- ...	Sumatra, Tenasserim, Malaya.
Derris affinis, Benth.	- ...	Java, Malaya.
Derris amoena, Benth.	- Lowland forests	- Tenasserim, Malaya.
Derris elliptica, Benth.	- Rocks. Cultivated	- Cambodia, Siam, Malaya.
Derris malaccensis, Prain.	- Forests	- Tenasserim, Siam, Borneo, Malaya.
Derris Yappni, Craib.	- ...	- Malaya.

Derris affinis and *D. uliginosa* are synonymous, so that the number of species is reduced to ten. Mc. Indoo, Sievers, and Abbott, in their paper published in the Jour: of Agric: Research, Vol: XVII p. 177, give some information on the toxic values for several species, but of the species known in Malaya only *scandens*, *uliginosa* and *elliptica* are mentioned. They state that *uliginosa* and *elliptica* were found to be satisfactory as insecticides and that *scandens* and the following species were not:—*D. Koolgibberah*, Baily, *D oligosperma*, K. Schum. (both from Australia) and *D. robusta*, Benth (from India) With the elimination of *D. scandens* the number of species in Malaya which might repay investigation is reduced to nine.

For a long time efforts were made to secure properly identified specimens of the species of *Derris* known to exist in Malaya, but without success. Eventually, however, again through the kindness of I. H. Burkill, authentic specimens of *D. elliptica*, *D malaccensis* and *D. thyrsiflora* were obtained. In addition to these several varieties of *Derris* were obtained, but their specific identity is mostly uncertain. They are as follows:—

Vernacular.	Identification.
Tuba rimba	*Derris elliptica*
,, merah	,, ,,
,, puteh	,, ,,
,, gagah	*Derris* sp.
,, standing	,, ,, (from Sarawak)
,, creeping	,, ,, ,, ,,

Both *malaccenss* and *thyrsiflora* exhibit toxic properties, and all these samples give the milky fluid of peculiar smell common to derris roots. There is very little distinction between the roots of *elliptica* and *malaccensis*, but *thyrsiflora* is easily recognised by its light colour and by the light scaly character of the root-bark. Having these varieties and species in hand, it was desired to compare their toxic content or their comparative behaviour towards insects. At the outset, however, it was evident that no facilities existed for making a true comparison. The toxic principles are changed by the use of heat, necessitating any extraction by solvents being performed under reduced pressure. In addition, extraction is difficult unless the roots are ground to an exceedingly fine powder. No suitable apparatus was available with which to conduct these operations.

As regards the water extract the same error which applies to extraction by chemical solvents is present if the roots are not ground equally fine, and pounding in a mortar is too inaccurate a process for true comparisons. Further, it has been found by Mc. Indoo that

water is not an efficient vehicle for derris unless the fine powder is suspended in it, and by straining the pounded or unevenly ground roots no certainty of having the same amount of suspension in each sample could be maintained. For these reasons it was considered that a comparison of the toxicities of the species would possibly be misleading if carried out in Malaya with its primitive laboratory facilities.

Apart from the inaccuracies likely to occur in the laboratory under these conditions, there is also the question of the age of the plant, it being very possible that unless plants grown under identical conditions and of exactly the same age were used, more errors would be introduced. It has therefore been decided that now properly identified plants of a few species can be obtained they should be handed over to some institution where full facilities for comparison exist. From one aspect however, a comparison of the toxicities such as can be done in a very rough way might be useful. Many estates in Malaya grow a little derris for use on the estate when required, and in this case the root and stems would be coarsely ground or pounded in a mortar, the water extract being used. From this point of view a few notes on the various varieties are given. In the laboratory an ordinary drug mill was used, the root being ground as fine as possible with this machine. The roots varied in their behaviour in the mill, and they were graded by inspection in the order of the fineness of the product. In Table III the root which gave the finest powder is placed first, that which gave the coarsest last. The moisture content was roughly estimated for each root and is included in the table.

TABLE III.

Order of fineness.		Moisture content %
Tuba rimba (finest)	...	7.4
D. elliptica	..	10.3
Tuba merah	...	3.3
,, creeping	...	9.4
D. malaccensis	...	9.3
Tuba gagah	...	7.3
,, puteh	.	8.0
,, standing	...	9.6
D. thyrsiflora (coarsest)	...	11.1

One gramme of the powdered roots was then weighed and pounded for two minutes in a mortar. The resultant pulp was squeezed through muslin in water and washed, the liquid being then made up with water so that the volume contained 1% of the dry root.

When the water extracts are left standing for twelve hours a fermentation process sets in, which appeared to be most active with

D. elliptica and *D. malaccensis*, a greyish scum being formed on the surface. Although this point has not been investigated, it is believed that this fermentation reduces the toxicity of the extract, since samples which had been left for some days showed a marked falling off in this respect. Associated with the scum is a gram-negative organism which appears as short chains 7—8μ. in length. All tests were therefore made with the freshly prepared extracts.

For these tests the larvae of a Pyralid, *Tirathaba* sp. were used, the total immersion method being employed. Since these larvae showed some susceptibility to sodium oleate it was not used in these tests, but the immersion period was increased to fifty seconds. Twenty larvae were used for each test, the results being shown in Table IV.

TABLE IV.

Derris Species.

D = Dead. C = " Comatose." A = Alive.

Root Used.	Strength. %	Results after 24 hours.		
		D.	C.	A.
D. elliptica	0.2	18		2
Tuba rimba	0.2	16		4
Tuba merah	0.2	14		6
Tuba creeping	0.2	12		8
Tuba gagah	0 2	10		10
D. malaccensis	0.2	8		12
Tuba standing	0.2	8		12
Tuba puteh	0 2	6	4	10
D. thyrsiflora	0.2	2		18

On referring to Table III it will be noticed how closely these results agree with the order of fineness of the powders obtained, so that the comparison is probably more in the nature of the ease with which the various roots can be prepared than of their toxic content. It is also noticeable that, with the exception of Tuba puteh, those which are known to be *D. elliptica* appear to be the most toxic. Other than the authentic *D. elliptica*, which appears to be the best, Tuba rimba, Tuba merah and Tuba puteh are almost certainly *D. elliptica*. As grown in Malaya there are variations in the plants,

Tuba rimba, Tuba merah and Tuba puteh being fairly easily distinguished from one another. The authentic sample of *D. elliptica* appears to be the same as the variety known as Tuba rimba, and from the results there appears to be little difference in toxicity. From these preliminary tests it would appear, therefore, that *D. elliptica* is the best of these species for use as an insecticide, and that the variety known locally as Tuba rimba is the best one to grow for use on estates.

PART II.

NOTES ON THE PESTS OF DERRIS.

Considerable interest has been shown recently in regard to growing derris ("tuba") for sale as the basis of insecticides and also as a convenient and cheap substance which can be used for the control of certain insects on estates. During the course of investigations on the various species and varieties of this plant some insect pests have been discovered, and since nothing can be found on the subject in the literature available it was thought that the publication of an annotated list of the pests so far recorded on derris in Malaya might be of interest.

Until quite recently the insects found feeding on this plant were limited to the leaves. When grown under plantation conditions there is always a certain amount of injury from leaf-eaters, but it is only occasionally of a serious nature. If grown on a large scale, however, this injury will in all probability increase in severity until control measures may have to be undertaken. The roots and stem on the other hand have lately been found to be attacked in store. Whether the infection took place in the field or after they were stored is not yet certain, but the damage done is of a serious nature and may occur in stores in this country and during transhipment. In the following notes a reference is given to the monograph which was accessible and also to the books dealing with this region of the world. References have been cut down as much as possible, full references being given in the book or monograph quoted. Common synonyms are given to facilitate reference. The distribution has as a rule been taken from the works quoted, while the notes on the life history and other details were obtained from our breeding records.

Among the leaf-eating insects many are not pests in the correct sense of the word, but they are nevertheless noted since they may develop in importance where derris is grown as a pure crop on a large scale. Control for leaf-eating insects will probaby be limited to hand picking, partly owing to the fact that there are no facilities for spraying on many estates where derris is grown, but largely because spraying operations would not only be of doubtful value with this crop owing to the great difficulty of applying the spray efficiently among the creeping stems and matted foliage, but the cost of such operations would rarely be an economic proposition. In the case of the root feeders, however, control by fumigation or other methods will have to be undertaken.

1. LEAF FEEDERS.

HESPERIIDAE.

Parata alexis, F.

Parata alexis, F.	Moore and Swinhoe, Lepid: Indica IX p. 253. Synonym-*Hasora alexis* F.
Distribution	- Java, Borneo, China, Ceylon, India, Burma, Andamans, Malay Peninsula.
Food Plants	- *Pongamia glabra* (India) derris (Malaya.)
Life History	- Larva greenish purple with darker fascia on dorsum, thinly clothed with whitish hairs; head large, brown. Rolls leaf and pupates inside; pupal period about 8 days.
Status	- Minor pest.
Control	- Hardly necessary at present; rolled leaves may be picked.

ARCTIIDAE.

Amsacta lactinea, Cram.

Amsacta lactinea, Cram.	Seitz, Macrolepid: of World, English Edn. X p. 251.
Estigmene lactinea, Cram.	Fletcher, Some South Indian Insects p. 368.
Creatonotus lactineus, Cram.	Dammerman, Landbouwdierkunde van Oost-Indië p. 130.
Distribution	- India, Ceylon, Burma, Sunda Islands, Philippines, Java, China, Japan, Malay Peninsula.
Food Plants	- Numerous. *Pennisetum typhoideum*, coffee and others in India; soy bean, lantana and others in Java; tea, chilies and derris in Malaya.
Life History	- Eggs laid in mass on leaf or shoots; larva black with long dark brown hairs arising from tubercles on body. and with red spots sub-dorsally, Feeds openly on leaf; pupates in ground; ceases feeding 2 to 3 days before pupation, pupal period 14 days.
Status	- So far not serious in Malaya, except on one occasion on chilies, but a serious local pest of *Pennisetum typhoideum* in India.

Control	-	**Hand picking and collection of egg masses sufficient at present.**

GEOMETRIDAE.

Anisodes obrinaria, Guen.

Anisodes obrinaria, Guen.		Hampson, Fauna of British India, Moths III p. 446.
		Synonym—*Anisodes obliviaria*, Wlk.
Distribution.	-	Khásis, Bombay, Nilgiris, Ceylon, Moulmein, Andamans, Borneo, Solomons, Malay Peninsula.
Food Plants	-	Derris (Malaya).
Life History	-	Larva feeds openly and pupates on leaf. Pupal period about 6 days.
Status	-	Hardly a pest.
Control	-	Not necessary.

PSYCHIDAE.

Mahasena sp.

An unknown species found doing minor damage. Other species of *Mahasena* are pests on coconut, arecanut and African oil palm in Malaya. Nothing is known at present about the species on derris.

LIMACODIDAE.

Belippa laleana, Moore.

Belippa laleana, Moore.		Hampson, Fauna of British India, Moths I p. 399.
		Dammerman, Landbouwdierkunde van Oost-Indie p. 112.
		Synonym—*Cheromettia ferruginea*, Moore.
Distribution	-	India, Ceylon, Rangoon, Bhamo, Java, Malay Peninsula.
Food Plants	-	Tea (Ceylon), coconuts, coffee, banana and others in Java. Derris (Malaya).
Life History	-	Larva stout, oval in shape, jelly-like; pale bluish green with yellow and black spots. Feeds openly, pupates in round cocoon.
Status	-	Hardly a pest.
Control	-	Unnecessary.

THYRIDIDAE.

Striglina scitaria, Wlk.

Striglina scitaria, Wlk. Hampson, Fauna of British India, Moths I p. 354.

Distribution - Japan, Formosa, India, Ceylon, Burma, Andamans, Borneo, New Guinea, Solomons, Australia, Fiji, Malay Peninsula.

Life History - Larva greenish yellow, first thoracic segment yellow, head brown; dark brown spots on 2nd. thoracic to anal segments; a few short hairs on body. Pupates in folded leaf; pupal period 8 days.

Food Plants - Dadap, *Bauhinia purpurea*, and derris in Malaya.

Status - Minor pest.

Control - Hand picking if necessary.

PYRALIDAE.

Lamprosema diemenalis, Guen.

Nacoleia diemenalis, Guen. Hampson, Fauna of British India, Moths IV p. 316.

Distribution - S. Africa, Formosa, Ceylon, India, Burma, Andamans, Sumatra, Java, Celebes, Fiji, Malay Peninsula.

Food Plants - In Malaya—Centrosema, soy bean, indigo, ground-nut; *Tephrosia candida*, *Sesbania aculeata*, *Clitoria cajanifolia*, *Calopogonium mucunoides*, *olichos* spp., derris.

Life history - Eggs on leaf; larva smooth, greenish grey above, green below, head ochreous. Pupates in folded leaves; pupal period 6 to 8 days. Larva parasitised by *Chelonus* sp., another Braconid, and an Ichneumonid.

Status - Fairly serious, especially when parasites are scarce.

Control - Hand picking usually sufficient, but spraying may have to be undertaken.

Maruca testulalis, Geyer.

Maruca testulalis, Geyer. Hampson, Fauna of British India, Moths IV p. 393
Fletcher, Some South Indian Insects, p. 440.

- Dammerman, Landbouwdierkunde van Oost-Indië, p. 189.

Distribution	-	Throughout Neotropical, Ethiopian, Oriental and Australian regions.
Food Plants	-	Tobacco (Java) *Tephrosia candida* and *Cajanus indicus* (Ceylon) beans (Porto Rico) pulses (India) In Malaya —beans, *Sesbania aculeata*, *Mucuna pruriens*, derris.
Life History	-	Larva pale greenish yellow with brown warts from which arise short hairs. Usually known as the 'bean pod borer' from its habit of boring into the pods, but in Malaya feeds on leaves as well, webbing them together. Pupa in silken case in folded leaves; pupal period 6 to 7 days.
Status	-	Very minor pest.
Control	-	Unnecessary.

Maruca amboinalis, Feld.

Maruca amboinalis, Feld. Hampson, Fauna of British India, Moths IV p. 394.

Distribution	-	Khásis, Nilgiris, Burma, Borneo, Amboina, Malay Peninsula.
Food Plants	-	*Tephrosia candida* (India) *Pongamia glabra* and derris (Malaya.)
Life History	-	Larva yellow with short single hairs arising from very small tubercles; head brown, large. Webs and folds leaves, pupating in silken cell; pupal period 7 to 8 days. Has not been observed eating the pods of the known food-plants.
Status	-	The commonest leaf-eating pest found on derris and may do considerable damage.
Control	-	Hand picking of larvae and pupae probably the most that can be done, but spraying may have to be resorted to.

EUCOSMIDAE.

Eucosma balanoptycha, Meyr.

Eucosma balanoptycha, Meyr. Meyrick, Rec. Ind. Mus., V p. 218.

Distribution	-	India, Malay Peninsula.
Food Plants	-	*Pongamia glabra* (India) derris (Malaya.)
Life History	-	Little known. Larva folds youngest leaves, pupating inside; pupal period about 6 days.
Status	-	Hardly a pest.
Control	-	Unnecessaay.

Eucosma defensa, Meyr.

Eucosma defensa, Meyr. - Meyrick, Exotic Microlepidoptera, II pt. 17 p. 517.

Distribution	-	Fiji, Malay Peninsula.
Food Plants	-	*Pongamia glabra* (Fiji) derris (Malaya).
Life History	-	Little known. Larva feeds on leaves; pupal period about 10 days.
Status	-	Hardly a pest.
Control	-	Unnecessary.

2. ROOT FEEDERS.

Some evidence of damage by insects to the roots of derris had been noted on several occasions before any insects were actually found. The first sample which was found with the insects present, however, yielded no fewer than four which were apparently feeding on the root while one or two others were present whose status could not be defined. Two Bostrichids, a Scolytid and a Tenebrionid were certainly feeding and the larvae of, it is believed, all four were found. For the present they have simply been separated as.—

Bostrichid No 2337.

,, No. 2338.

Tenebrionid No. 2336.

Scolytid No. 2341.

In order to confirm whether the infested roots were really *Derris* sp or those of some other plant which had been mixed with the derris, a portion of the uneaten material was taken and an extract made in the usual way. This was then tested on some caterpillars

and proved to be toxic, as well as having the typical appearance and smell of derris extracts. A portion of the excreta from Bostrichid No. 2337, which was the dominant insect, was then taken and tested in the same way. The extract prepared from the excreta had no effect on other members of the same batch of caterpillars nor on the nymphs of *Dysdercus cingulatus*, F. which are particularly susceptible to derris. It was thus concluded that the tubatoxin and other substances contained in the root were almost, if not entirely, destroyed by the digestive fluids of this insect.

The life history of these insects is under investigation, but Bostrichid No. 2337 is certainly the most important of the four mentioned. One is apparently parasitised by a (?) Braconid, a cocoon having been found in one of the galleries attached to the remains of a larval skin. In the samples obtained it is estimated that 50% of the roots had been destroyed, and with continued infestation there appears to be no reason why the whole of the crop should not be lost.

Infestation by these insects will have to be watched for where derris is stored, and strict sanitation will be required. In addition to this fumigation will probably have to be resorted to. It will not be possible to employ heat as a control measure owing to the chemical changes brought about in the toxic principles by its agency. Since writing the above several additional cases of infestation of stored derris roots have been reported. In each case Bostrychid No. 2337 was the dominant if not the only insect present, and the damage done was of a very serious nature, In one case practically the whole of the crop from an estate was destroyed in the store. and since the infestation is capable of increasing during transit, it behoves growers to examine their roots most carefully during storage and before shipment.

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OBSERVATIONS ON COVER CROPS AT CASTLETON ESTATE.

By B. Bunting and T. D. Marsh.

THE following notes are the result of observations made on a number of cover crops now being grown at Castleton Estate, Teluk Anson.

The plots are only small, being about 1/20 acre in extent, and were primarily laid down with the undermentioned objects:—

(i) To ascertain the suitability of various cover plants for growing on the flat alluvial clays of the Lower Perak District.

(ii) Demonstration purposes.

With the exception of *Mikania scandens* and *Vigna oligosperma*, which were propagated from cuttings, the whole of the cover plants were raised from seed.

The seed was sown on the various plots during the last week in October, 1924, in well-changkolled and clean land so that the observations are made over a period of approximately one year.

There was one coconut palm, about 15 to 20 feet high to the base of the leaves, growing in the centre of each plot and the soil conditions were very similar throughout the whole of the plots.

Canavalia ensiformis.—Seeds of this cover plant were dibbled in changkolled land 8 ft. apart each way. The plants came away vigorously, producing a good growth of green material and would be useful as a quick-growing green manure for changkolling into the soil for intensive forms of cultivation. It grows about 3 feet high and covers the ground fairly well. The cover produced a fair crop of seed after which it died out. After the plants were fully grown and had flowered, about 10 per cent of them died as a result of a fungus disease which attacked the roots and main stem. The cover lasted about 6 months only and the plant did not re-seed itself, probably because the surface of the ground was too hard.

A second lot of seed was dibbled in between the former rows of plants in April, 1925, without further changkolling. These plants have made very poor growth and are practically a failure.

Calopogonium mucunoides.--Seed was sown in rows 3 ft. apart each way in October, 1924. After a period of about 3 months, the plants had completely covered the ground, whilst after 5 months they formed a dense cover 1 foot deep and at that time were seeding to a limited extent. It is particularly suited to this class of soil and makes an excellent cover. In the original 1/20 acre plot it has not grown much under the shade of the coconut palm and even the few plants that grew appear to be dying out, which may be due to the fact that the soil is

very poor near the palms. In other areas, however, under small coconuts about 1½ years old it flourishes and has to be continually taken away from the palms to prevent it climbing up the trunk. During the whole period this cover has shown vigorous growth, but there are a few patches where all the leaves appear to be scorched and the plants have died out.

Cassia hirsuta. The germination of the seed of this cover was poor but the few plants that grew were fairly good. Seed was dibbled in 2 ft. x 2 ft. apart. The plants are now almost 5 to 7 feet high, but the growth is fairly open in character and the cover throws little shade, consequently has little effect in checking weeds. In the re-sown parts of the plot the plants have not done so well, probably because the land was not rechangkolled and the rain had beaten the soil down somewhat before re-sowing. This cover is not altogether a complete success.

Cassia mimosoides.—Seed of this cover was sown about 2 ft. apart each way. One to three seeds were dibbled in each hole in well-changkolled land, but after germination only one plant was left per hole. The growth was very slow at first, the plants taking several months to cover the ground and provide sufficient shade to check the growth of weeds. When the plants attained a height of about 2½ to 3 feet they completely covered the ground and provided such dense shade that no weeds grew. The plants are still growing vigorously and have now attained a height of 10 to 12 feet. This cover is almost impenetrable, but has become somewhat woody.

Cassia occidentalis.—Seed was dibbled in 2 ft. x 2 ft. apart. The plants grew into a straggling weedy cover about 4 feet high with no vigour, consequently giving no shade. This cover plant flowered about the middle of December, 1924, and is undoubtedly useless on this type of land. Half of the plot was pruned to about 1 foot off the ground during March, but the cover never recovered from this pruning and gradually died out over the pruned area.

Centrosema Plumieri.—The seed of this cover was dibbled in 3 ft. x 3 ft. apart in what is probably one of the worst areas of these demonstration plots, consisting of a wet plastic clay which is difficult to drain. On part of the plot, which was fairly dry, the cover, after a struggle, has become fairly well established and is looking healthy. On the rest of the area it has scarcely grown at all. It might be stated here that this plot adjoins on one side *Vigna oligosperma* and on the other side *C. pubescens*, but the latter plot was the best. All the three plots have soil of a similar character.

Centrosema pubescens.—Seeds were dibbled in 3ft. x 3ft. apart. This cover was planted on a wet patch of ground and for this reason was not altogether a success. It has been re-sown over part of the plot three times and at first was a very straggling cover almost choked by weeds in spite of the fact that since sowing it was weeded several times. During the dry weather it improved wonderfully and has now produced a fairly good cover. It is far superior to *C. Plumieri* but, like the latter, it will not thrive under wet conditions.

This cover dies out in patches similar to *C. Plumieri* and *Calopogonium mucunoides.* The plant takes a long time to become established and the soil conditions are probably unsuitable for its successful growth.

Clitoria cajanifolia.—Seed of this cover was sown 2 ft. x 2 ft. apart, but germinated badly and part of the area had to be re-sown. Although slow in getting established the plant is now showing a fair growth, but it is not exactly suitable as a cover crop. It is somewhat woody and hardly provides sufficient shade to keep down weeds. As the plant has a habit of throwing out numerous branches on the ground level it would make an excellent cover for planting in close rows on hill sides in place of Citronella and Lemon grass, to check erosion of the top soil.

Crotalaria incana.—Seed was sown 2ft. x 2ft. apart. This cover has a very weak growth and the plants are stunted. The plants commenced flowering at the end of December when only about one foot high and have been seeding freely ever since. This cover is useless on this type of land and has not yet covered the surface The best plants are 3 to 4 feet high, but they have a stunted leaf growth and generally lack vigour.

Crotalaria striata —This cover has been vigorous from the time of sowing. The seed was dibbled in 2 ft × 2 ft. apart and the plants commenced flowering about the middle of December. A few weeks after germination this cover gave sufficient shade to stop the growth of all weeds. The plants are now 10 feet high and, judging from the large bulk of green material produced, would make an excellent green manure. Half of the plot was cut down to 1½ feet from the ground on two occasions and this is now 6 feet high again. The uncut part of the plot has been seeding freely for the past four months.

Crotalaria usaramoensis.—Seed of this cover was dibbled in 2 ft. × 2 ft. apart. This plant has produced the heaviest and quickest growth of all the covers under observation, taking possession of the ground very quickly and choking out all weed growth. Flowering commenced at the beginning of December and the plants, which have been seeding freely for the past 5 months, have now attained a height of 10 to 12 feet. Half of the plot was cut down on two occasions to 1½ feet from the ground and this has now grown again to a height of about 6 feet, producing a large quantity of green material. A few plants in the uncut part of the plot have recently died, probably as a result of seeding too freely. The objection to this cover is that it is comparatively short-lived.

This crop from all appearances, has a high value as a green manure and may be kept growing for a longer period by constant pruning, thus preventing it seeding. The heavy clay type of soil evidently suits this cover.

Desmodium tortuosum.—The plants produced were weedy and spindly, about 2 to 3 feet high, and were a complete failure. The

seed was sown 2 ft. x 2 ft. apart and the plants flowered in the middle of December, producing ripe seed at the end of January. The original plants are practically all dead, but the new seedlings are now growing. It has been necessary to weed the plot monthly. This plant although practically of no value as a cover might prove useful as a fodder crop if sown thicker.

Indigofera hirsuta.—Seed of this cover was dibbled in 2 ft. x 2 ft. apart. The plant has made a very good growth of green material and appears to do equally well under shade of a large coconut palm as out in the open.

The ground was completely covered about 4 months after sowing. This plant retains a vivid green colour and has bright pink flowers with clusters of very hairy pods at the ends of the flowering stalks, both of which have a hanging or drooping habit. The whole plant is covered with brown hairs. It makes a very attractive cover having a semi-erect growth, but spreads over the ground without becoming a dense mass of dead brown stalks as in the case of *Mimosa invisa*. The plant grows to a height of about 2 feet and has almost taken possession of the ground, but there is a little grass growing on the plot. Care and attention are required to get it established, and further trials on this type of land, appear to be warranted.

Leucaena glauca.—The germination of the seed was very bad and only about half a dozen plants were established. The growth was not at all promising and although these few plants have 1/20 of an acre of ground they have not thrown out any branches. They mostly consist of single, nearly upright, stems about 3 to 5 feet high, bearing a few flowers and pods, consequently practically no shade is thrown and the cover would have to be sown very thickly to produce a stand of bushes sufficient to prevent the growth of weeds.

Mikania scandens.—A few cuttings were received from Serdang and were planted 3 ft. x 3 ft. apart. Only three or four of these cuttings survived the train journey and the ultimate transplanting, and they had to be watered to keep them alive. As soon as sufficient rain had fallen, the plants commenced to grow very vigorously and after about four months the whole plot was covered to a depth of 6 to 12 inches. All weed growth was checked and the expression " the mile a minute plant," which is frequently used in relation to this cover, aptly describes it. One cutting planted in the centre of four rubber or coconut trees would be sufficient to give a complete cover to this area in a short space of time. Shade does not appear to affect it, but conditions on these plots, as regards shade, hardly warrant an expression of opinion. This cover plant unfortunately is non-leguminous and therefore does not enrich the soil.

Mimosa invisa.—This cover is eminently suited to this type of soil. The seed was dibbled in 3 ft. x 3 ft. apart and in about three months the ground was so completely covered that all weed growth was checked. It has been necessary on several occasions to keep the cover from spreading to other plots by turning it back on the edges of the plot. This particular plot is now, and has been for the past 4 or 5 months, a solid mass of green material.

Sesbania aculeata.—This plant has given very poor results. The seed was dibbled in 2 ft. x 2 ft. apart and the plants grew to a height of about 8 feet. This cover throws no shade and the plants first flowered about January 15th. Half of the plot was pruned to 1½ feet from the ground and this operation practically killed off all the plants, whilst those on the unpruned portion of the plot are now dying out. The plots had to be weeded monthly, and this cover must be described as a failure.

Sesbania sericea.—The remarks made about *S. aculeata* apply to this cover, but it does not live so long. Seeds were sown 2 ft. apart each way. The young plants came away at first slightly better than *S. aculeata* and flowered in the middle of December, but now they are all dead. This plant is of no use as a cover crop.

Tephrosia candida.—Seed of this cover was sown 3 ft. x 3 ft. apart and produced good vigorous plants, which have grown to a height of about 10 feet. The plant forms a thick cover suppressing practically all weeds. Half of the plot was cut back once to 1½ feet from the ground. This portion has grown almost as tall as the uncut area, is more dense in growth and has formed a better cover. This plant forms one of the most satisfactory cover crops, both from the point of view of shade and green manure.

Tephrosia Hookeriana var. amoena.—This plant is not so vigorous as *T. candida*, but if the seed is sown thicker than the latter, a good cover growing to a height of 3 to 4 feet will be obtained. It seeds profusely and makes a very satisfactory cover. The individual bushes are not so dense as *T. candida*, consequently unless the seed is sown more thickly the shade is not so heavy.

Tephrosia purpurea.—The seed of this cover was sown 2 ft. x 2 ft. apart and the plants have attained a height of about 2 feet. This is rather a delicate bushy cover. Although probably valuable as a green manure it is not dense enough to suppress weeds and for this reason the seed would have to be sown very thickly on the ground. The plant is now seeding heavily.

Tephrosia Vogelii.—This cover plant was tried but the seed failed to germinate. A fresh supply of seed was procured, but the growth of the plants is so small that further comments are unwarranted until the trial is more prolonged.

Vigna oligosperma syn. *Dolichos hosei.*—Owing to the difficulty of obtaining seed this plant was propagated from cuttings, which were planted 3 ft. apart each way. This well-known cover plant has been anything but satisfactory probably owing to soil conditions, having been planted on a wet heavy clay. It should, however, be stated that in this district the plant has been successfully established on alluvial clay land under the shade of old rubber.

SUMMARY.

Calopogonium mucunoides, Cassia mimosoides, Centrosema pubescens, Crotalaria striata, C. usarmoensis, Indigofera

hirsuta, Mikania scandens, Mimosa invisa, Tephrosia candida and *T. Hookeriana var. amoena.* have given the best results from the point of view of producing a good cover and checking the growth of weeds.

Canavalia ensiformis, Cassia mimosoides, Crotalaria striata, C. usaramoensis, Indigofera hirsuta, Tephrosia candida, T. Hookeriana var amoena and *T. purpurea* produced large quantities of green material and therefore are eminently suitable for use as a green manure, more particularly as they are all leguminous plants.

Mikania scandens and *Vigna oligosperma* were the only cover plants which gave any indication of being successfully established under shade on this type of soil.

Centrosema Plumieri, Cassia hirsuta, C. occidentalis, Clitoria cajanifolia and *Vigna oligosperma* showed very poor growth indeed, probably owing to the soil conditions being unsuitable, whilst *Crotalaria incana, Desmodium tortuosum, Leucaena glauca, Sesbania aculeata, S. sericea* and *Tephrosia Vogelii* proved a complete failure.

Canavalia ensiformis, Crotalaria incana, C. striata, C. usaramoensis, Indigofera hirsuta, Sesbania aculeata and *S. sericea* have the objection of being only short-lived and therefore the areas must be periodically replanted with fresh seed.

Although the plots are small and the trials only of very short duration the above results give some indication as to the comparative values of the different cover plants on this particular type of soil.

Received for publication 26th September, 1925.

NOTES ON THE CULTIVATION OF ANNATTO.

BY B. BUNTING.

ANNATTO, *Bixa orellana*, is a large quick-growing shrub or small tree, native of tropical America.

The plant is cultivated on a small scale in India, Ceylon, the West Indies and other tropical countries for the dye afforded by its seeds. It also makes a good hedge, screen or windbreak.

CULTIVATION.

The tree is readily propagated from seed which is sown broadcast in slightly raised nursery beds about 5 feet wide. As soon as the seedlings appear they should be thinned out to about 6 inches apart. When the young plants are from 9 to 15 inches high they should be planted out in the field at distances of from 15 to 18 feet apart. The plant is very hardy indeed and requires no shade either in the nursery or when transplanted in the field.

The tree makes rapid growth in the open and under ordinary conditions will attain a height of 10 to 12 feet at the age of about two years, when it will begin producing fruit. It will continue to fruit for a number of years and the only attention it requires is systematic weeding and pruning of any dead branches.

There are apparently two varieties, one with a white flower with greenish capsules and the other with a pink flower and reddish capsules, the latter being the one usually cultivated. The flowers occur in terminal clusters while the fruits are ovoid, spiny, two-valved pods, containing from 30 to 50 seeds. The seeds are surrounded by a scarlet tissue from which the dye is obtained.

YIELD.

The fruits are collected when nearly ripe and as the shells dry they burst open. The seeds are separated from the pods and after being thoroughly dried in the sun they are screened and shipped without removing the scarlet covering containing the dye. In this condition they are packed in double gunny bags and marketed as Annatto "seed." Unfortunately the seed does not keep well and old stock is worth very little compared with fresh seed.

The yield is somewhat variable, but records from the Government Experimental Plantation, Serdang, show that the plant commences to fruit at about two years from the date of planting. The first year's crop gave an outturn of 5 cwt. of dry seed per acre and it is probable that this yield will be exceeded as the trees become older. Although the tree continues to produce fruit all the year round the

heaviest crops are obtained in the months of March and September, following the dry periods. The market price fluctuates considerably and it has been known to vary from 3d. per lb. up to as high as 1s. 6d. per lb. C. I. F. London. The present price is about 8d. per lb.

USES.

Annatto dye is used to a small extent in colouring lacquer, silk, calico and wool, but its principal use is as a colouring matter for various foodstuffs more particularly butter and cheese and there is a regular demand for the product for this purpose. The active principle of annatto is annatoin.

MARKETS.

Hitherto there has only been a limited demand for this product and the consumption for the United Kingdom was within the region of 100 tons per annum, whilst a corresponding quantity was imported into the United States. The whole business is a comparatively small one and the chief supplies come from Jamaica and Southern India, where the crop apparently grows wild.

If the food preservative proposals issued by the Ministry of Health are put into operation the use of gamboge and a number of coal-tar dyes giving a yellow colour, will be prohibited. This might mean that annatto seed, which at the present time is only used in very small quantities, will probably find a greater outlet, as this is one of the very few yellow dyes upon which a veto has not been placed. This would of course have the effect of stimulating interest in the Annatto market.

In connection with a suggestion that annatto might be cultivated in Malaya as a commercial crop, enquiries have been made by the Imperial Institute, at the request of the Malay States Information Agency, regarding the present position of the market for annatto and the chief industries in which the product is now used.

As a result of these enquiries one firm of merchants stated that the demand for annatto appears to be increasing but in their opinion it is doubtful whether the total present consumption would warrant the seed being produced as a cultivated crop. They considered that the demand would require to be quadrupled before such a course would be worth while.

If the producer were in a position to hold over his stock and to distribute it evenly over the year the business would be more profitable, but the lack of keeping quality of the product prevents this with the result that there is either too much on the market or none at all.

The wild crop from Southern India is rushed home as early as possible, usually about the end of February and early arrivals realise good prices. If a cultivated crop could be placed on the market earlier than the wild crop an increased price would be obtainable.

Further, a firm of manufacturers of cheese and butter colours, etc., who use annatto seed for the purpose, stated that the price of the best annatto still remains at a high figure ranging from 1s. to 1s. 3d. per lb, according to the quality and colour of the seed.

GENERAL.

The information obtained from leading firms of merchants, brokers and consumers suggests that no great increase in the demand for annatto is expected by the trade in consequence of the proposed new regulations of the Ministry of Health, but the possibility of marketing a cultivated crop earlier than the wild crop may be worth consideration.

A sample consignment of 10 cwts. of seed produced from a cultivated plot at the Government Experimental Plantation, Serdang, will shortly be forwarded home and, with the object of finding the most suitable market, it is hoped that it will be possible in future to make regular quarterly shipments of about this size.

Received for publication 15th September 1925.

LONDON MARKET PRICE LIST 3rd QUARTER 1925.

Oil Seeds.

Castor (Bombay)	-	£22.15.0	per ton.
Copra (Ceylon)	-	£31.2.6	,,
Do. (Straits)	-	£30.2.6	,,
Cotton (Egyptian)	-	£12.12.6	,,
Do. (Bombay)	-	£11.17.6	,,
Groundnuts (Gambia, undecorticated)	-	£18.15.0	,,
Do. (Chinese, decorticated)	-	not quoted.	
Linseed (Bombay)	-	£21.15.0	,,
Do. (Plate)	-	£18.17.6	,,
Palm kernels. (West African)	-	£21.0.0	,,

Oils.

Castor (Madras)	-	55/-	per cwt.
Do. (Pharmaceutical)	-	63/-	,,
Do. (1st pressing)	-	58/-	,,
Do. (2nd pressing)	-	56/-	,,
Coconut (Cochin)	-	Nominal steady.	
Do. (Ceylon)	-	45/3	per cwt.
Cotton seed (Egyptian, crude)	-	42/6	,,
Do (Bombay)	-	39/-	,,
Groundnut (oriental, crude)	-	49/6	,,
Do. (English)	-	49/-	,,
Linseed (Calcutta)	-	48/-	,,
Do. (Plate)	-	47/6	,,
Palm (Lagos)	-	£39.10.0	per ton.
Do. (Sumatra)	-	£36.5.0	,,
Palm kernel	-	41/6	per cwt.

Oil Cakes.

Coconut	-	£10.7 6	per ton.
Cotton (Egyptian seed)	-	£8 10.0 to £8.15.0	,,
Cotton (Bombay seed)	-	£7.2.6 to £7.10 0	per ton.
Groundnut (decorticated)	-	£10 7.6 to £10.15.0	,,
Linseed	-	£12.12.6 to £13.7.6	,,
Palm kernel	-	£7.15.0	,,

Essential Oils.

Cajeput	-	2/10	per b.
Camphor (Chinese, crude)	-	2/6	,,
Do (Japanese refined)	-	2/9	,,
Camphor (oil)	-	51/-	per cwt.
Cinnamon (Ceylon leaf)	-	5/1 to 5/6	per lb.
Citronella (Ceylon)	-	2/1 to 2/2	,,
Do. (Java)	-	3/9	,,
Clove	-	6/9 to 7/-	,,
Lemon grass (Cochin)	-	4/-	,,

Essential Oils—*contd.*

Lime (West Indian, expressed)	-	not quoted.	
Do. (West Indian distilled)	-	9/3 to 9/6	per lb.
Patchouli (Penang)	-	14/6	"
Do. (Mysore)	-	No offers.	
Vetiver (Bourbon)	-	50/- per lb.	(nominal)

Spices.

Areca nut	-	57/6	per cwt.
Cinnamon (Ceylon)	-	1/8 to 1/11	per lb.
Cloves (Zanzibar)	-	11d. to 11½d.	"
Do. (Penang)	-	2/- to 2/6	"
Ginger (Japan)	-	90/-	per cwt.
Do. (Jamaica)	-	90/- to 120/	"
Mace (mid. to good)	-	3/7 to 4/2	per lb.
Nutmegs (West Indian)	-		
100's	-	2/-	per lb.
80's	-	2/2	"
Pepper (Singapore black)	-	9d.	"
Do. (Singapore white)	-	1/1½	"

Drugs.

Ipecacuanha	-	8/6	"

Natural Dyestuffs & Extracts.

Annatto (seed)	-	nominal.	
Gambia (block)	-	57/- to 60/-	per cwt.

Gums & Resins.

Guttapercha	-		
" Good to Fine	-	2/9 to 6/-	per lb.
" Low to Medium	-	9½d. to 1/7	"

Fibres.

Cotton (American Go to Mid)	-	12.29d. to 13.94d.	nom.
Do. (Egytian Sakellaridis, G. F. to fine)	-	29.10d. to 37.85d.	"
Hemp (Manilla, "J" grade)	-	£45.10.0	per ton.
Do. (Mauritius)	-	£36 to £48.10.0	"
Do. (New Zealand)	-	£36 to £38	"
Do. (Sisal)	-	£28 to £48	"
Kapok (Indian)	-	10¾d. to 11d.	per lb.
Do. (Java)	-	1/2 to 1/2½	"

Foodstuffs.

Cocoa (Ceylon plantation)	-	85/- to 110/-	per cwt. (in bond)
Coffee East India	-		
Superior	-	160/- to 165/-	per cwt.
Medium	-	130/- to 140/-	"

Foodstuffs—*contd.*

Sugar (Java white)	- 15/6 per cwt. (excluding duty)	
Tapioca (Penang, flake)	- 2¼d.	per lb.

Chemical.

Acetic acid (glacial)	- £66	per ton.
Do. (80% comml.)	- £38	,,
Acetone	- £78	,,
Ammonia (.880)	- £23	,,
Calcium acetate (grey)	- £15	,,
Citric acid	- 1/3½d.	per lb.
Formalin (40% vol.)	- £28.10.0 to £39	per ton.
Sodium bisulphite (60-62%)	- £17	,,
Sodium sulphite (anhydrous)	- £27.10.0 to £28.10	,,
Wood Kreosote (unrefined.)	- 2/9	per gallon.

The market for oil seeds and oils has generally been quiet, but prices have been well maintained, and will probably remain steady. Amongst oil cakes there has been a big demand for coconut cakes; linseed cakes has attracted good sales considering the high prices ruling: while palm kernel cake supplies are steady with supplies getting into a very small compass.

Spices remain at about the same level as last quarter.

Fibres of all kinds stand at lower prices, the hemps in particular being much easier. Chemical call for no comment.

This Market Price List is based on quotations contained in the following periodical and lists

Lewis and Peat Ltd., Monthly Prices current (Baltic Dept). 2nd July 1925.

Lewis and Peat Ltd., Monthly Prices current West Indian etc. 27th July 1925.

Fertilizer and Feeding Stuffs Journal 12th August 1925, 26th August 1925.

Chemist and Druggist 15th July 1925, 22nd July 1925.

Perfumery and Essential Oil Record, August 1925.

British Trade Journal, August 1925.

Chemical Trade Journal, 28th August 1925.

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PERIODICAL TAPPING OF HEVEA.

1. *The experimental basis of periodical tapping.*

J. GRANTHAM, M.A.

2. *The effect of alternate periods of tapping and resting on the quality of the rubber.*

B. J. EATON AND R. O. BISHOP.

Part I.—*The Experimental Basis of Periodical Tapping.*

Periodical tapping, i.e. where periods of daily tapping alternate with periods of rest, has of late years attracted much attention, and alternate monthly tapping on a half of the circumference has become the standard system on the East Coast of Sumatra. The historical development has been extensively treated by Maas (1). The purpose of the present paper is to show the basis on which this system rests as shown by experiments on the estates of the Hollandsch Amerikaansche Plantage Maatschappij: (property of the United States Rubber Plantations, Inc.) in Sumatra. Several past and present members of the company's research staff have contributed to the carrying out of the experiments described below, in particular, M. D. Knapp, who initiated Experiment 1 and E. M. Blair who has been in direct charge of the experiments in later years. For several years prior to 1922 the system of daily tapping a single cut on one third of the circumference was the standard system in Sumatra and had been shown to be the best yielding daily system consistent with conservative use of the bark. This system therefore formed the basis of comparison in the development of the new system.

Experiment. 1.—This experiment was started in July 1918 on Kisaran estate for the purpose of comparing one-third daily with one-half alternate day which preliminary experiments had indicated as a

(1) Het tapsysteem van Hevea brasiliensis op proefondervindelijken grondslag—Maas. Archief voor de Rubbercultuur in Ned. Indie, Jaar 9, No. 1, Januari 1925.

(The tapping system of Hevea on an experimental basis).

possible alternate system. The experiment was started on young (4 year old) trees not previously tapped and consisted of fifteen rows each of 100 trees of the one system alternated with fifteen rows of the other system. The alternate day trees were all tapped the same day and rested the next day. Each tapper tapped an equal number of trees of each system to eliminate variation due to the coolie. The maximum difference possible from accidental variations was calculated to be 6 per cent.

The tapping surfaces were laid out as follows :—

One-third *Daily System.*—Bark consumption $1\frac{1}{2}''$ per month.

1st One-third.	$13''$ allowing $1''$ for opening and $3''$ from the ground, giving $9''$ of tappable virgin bark	6	months.
2nd One-third.	$22''$ giving $18''$ of tappable virgin bark	12	,,
3rd One-third.	$28''$ giving $24''$ of tappable virgin bark	16	,,
4th One-third.	$28''$ giving $15''$ of tappable virgin bark	10	,,
		44	,,

Leaving $9''$ renewed bark 44 months' renewal.

5th One-third. $28''$ giving $6''$ of tappable virgin bark, $18''$ renewed bark 48 months old.

All subsequent surfaces laid out at $28''$ giving 48 months' renewal.

One-half *alternate day system.*—Bark consumption $\frac{3}{4}''$ per month.

1st half. $13''$ giving $9''$ of tappable virgin bark.
2nd ,, . $22''$ giving $18''$ of tappable virgin bark.
3rd ,, . $22''$ giving $9''$ of tappable virgin brrk.

Leaving $9''$ renewed bark 4 years old.

All subsequent surfaces at $22''$ giving 4 years' renewal.

The relative yields of the two systems are shewn in Table 1 below.

TABLE I.

System.	1918 half year.	1919	1920	1921	1922	1923	1924	1925 to June.	Total July 1918 to June 1925.
One-third daily.	100	100	100	100	100	100	100	100	100
One-half alternate day.	74.9	89.3	96.0	99.8	97.1	98.4	105.8	109.5	98.7

Thus while in the early years there is some loss from the half circumference alternate day as compared with the one-third daily, this is made up in later years and, over seven years, the yield is practically the same, with a tendency to be higher in future. The increased production in later years is probably connected with a better bark renewal, which was shown by measurements in January 1923, on bark which had renewed for two years, of 450 trees in each plot to be 7 per cent better in the alternate day plots.

In practice a longer renewal period than the four years given in these plots would be allowed, but since this means going higher on the tree, where the yield is less, the daily system (which would commence higher) would be prejudiced relatively to the alternate-day system.

The advantages of the longer cut and the alternate-daily tapping system were first evident about 1921 and it was also at this time that the alternate-period systems first began to arouse interest and the possibility of substituting an alternate-period system for an alternate day system was considered. This led to the planning of the two following experiments.

Experiment 2 (a).—This experiment was carried out on nine years' old rubber on Soengei Baleh estate, beginning March 1921 on a whole division of 630 acres. The tapping cut was on one-third of the circumference. The division was divided into fifty-eight fields, each tapped by one coolie. Each field was divided into two equal parts, which, in the odd fields, were tapped on alternate days and in the even fields, in alternate months The experiment ran for ten months, and the percentage relation of the yields was :—

Alternate day	...	100
Alternate month	...	104

The maximum accidental error was calculated to be 5 per cent.

Experiment 2 (*b*).—This experiment was started in March 1922 on six years' old rubber, not previously tapped. Cuts were laid out on one half of the circumference. The total area was fifty acres divided into ten tapping fields, each divided into two halves, tapped alternate-daily in the odd fields and alternate-monthly in the even fields, as in the previous experiment. In order to eliminate errors due to the coolies, they were rotated monthly, thus, after ten months, each coolie had tapped each field.

This experiment ran for thirty five months until January 1925, at the end of which time the percentage relationship of the yields was :—

Alternate day	...	100
Alternate month	...	105.9

Thus while the differences are not outside the range of accidental error, in each experiment, the alternate-month system gave

more than the alternate-day and it may be safely concluded that it is equally as good and probably a little better. The alternate-month system is preferable from an organisation stand-point and enables various economies to be made, since attention need be concentrated only on the area in tapping during the month.

It appeared that the half alternate-month sytem was a desirable one compared with the one-third daily since it entailed no loss in yield and effected a very great economy in tappers and supervision.

It still remained to be shown whether the period of alternation chosen, viz. one month, was the best and for this purpose a further experiment was laid out.

Experiment 3.—This experiment was started in May 1923 on an area of fifty acres of uniform twelve years' old rubber on Boenoet estate. The tapping system was one third of the circumference and all tapping cuts at the beginning of the experiment were laid out with the lower end of the cut at 28″ from the ground. Bark consumption was regulated at 2″ per tapping month. There were five series of plots :—

(1) Half month tapping, half month rest.
(2) One month tapping, one month rest.
(3) Two months tapping, two months rest.
(4) Four months tapping, four months rest.
(5) Six months tapping, six months rest.

Each series consisted of twelve rows of one hundred trees i. e a total of sixty rows, every fifth row being the same series. The area was divided into six fields of ten rows each, of which five rows were always in tapping and five resting, the period of tapping or rest of a given row being determined by the series to which the row belonged. Each field was tapped by one coolie who tapped across the rows, thus tapping all series at the same time. The latex was collected separately from each series and each day made into one large sheet for each series, the sheets being subsequently dried and weighed. Owing to previous experiments which affected the bark renewal on the next tapping surface, the maximum duration of this experiment was limited to two years, and it therefore ended on April 30th, 1925, after twenty-four cycles of tapping and rest of half month periods, twelve of monthly, six of two monthly, three of four-monthly and two of of six-monthly periods. The percentage difference between two series, which could be due to accidental variation, was calculated to be 6.5 per cent over a minimum of six months.

The relative yields of the various series for the two years are shown below, expressed as percentages of the alternate-month series:—

Alternate half months	...	100.9
Alternate months	...	100
Alternate two months	...	99.5
Alternate four months	...	91.6
Alternate six months	...	86.8

It will be seen that there is no appreciable difference in the yield of the first three periods, but that the four-month and six-month periods give distinctly lower yields. It is possible that, over a longer

period, these longer alternations of tapping and rest might show improved figures since, in the present experiment, they passed through only three and two complete cycles respectively.

It is evident however that, initially at any rate, loss would follow the adoption of these long periods, but periods up to two months can be adopted with safety.

Notes on the concentration of the latex in Experiment 3.—The different periods of rest and tapping have a marked effect on the concentration of the latex. In the experiment, daily records were not kept but, from the monthly average concentrations given below, the effect of the varying periods is well shown :—

TABLE II.

Month.	Percentage of dry rubber in latex.				
	Series No. 1.	Series No. 2.	Series No. 3.	Series No. 4.	Series No. 5.
1923					
May -	40.8	37.2	38.8	39.2	38.7
June -	41.8	41.7	37.6	38.0	37.6
July -	44.2	42.2	44.0	38.0	37.7
August -	44.9	43.9	40.0	39.1	38.5
September -	42.5	41.7	41.7	42.7	35.6
October -	42.4	41.3	37.6	38.7	36.1
November -	42.0	38.3	44.3	36.4	42.7
December -	41.5	41.7	36.6	35.6	39.2
1924					
January -	42.2	39.9	42.6	44.9	38.8
February -	42.3	40.8	37.1	37.3	38.0
March -	40.5	40.5	42.9	38.0	39.0
April -	40.6	39.6	36.6	35.3	34.7
May -	39.4	37.9	40.2	41.6	40.8
June -	38.9	38.6	36.1	36.7	34.0
July -	40.6	38.5	41.8	35.1	33.5
August -	41.1	40.4	37.5	37.6	35.0
September -	37.5	36.8	39.9	38.6	31.8
October -	38.5	38.8	36.9	36.9	34.5
November -	38.7	37.9	41.2	32.7	39.2
December -	38.0	36.4	32.8	31.9	32.3
1925					
January -	38.4	37.3	39.3	40.0	32.5
February -	38.4	37.4	33.0	32.6	32.6
March -	38.8	37.0	38.8	33.4	33.9
April -	38.9	37.1	32.8	32.7	31.6
Two year period -	39.9	38.7	38.1	36.6	35.3

Series	1,	tapped ½ month,		rested ½ month.	
,,	2,	,,	1 ,,	,,	1 ,,
,,	3,	,,	2 months	,,	2 months.
,,	4,	,,	4 ,,	,,	4 ,,
,,	5,	,,	6 ,,	,,	6 ,,

Figures in heavy type indicate change of plots from tapping to rest period and vice versa. For series No. 1, this is every half month and cannot be shown.

It will be seen that, with the longer periods, the concentration is always higher in the first month after tapping commences and diminishes up to the last month before the rest period. The daily figures would show this feature in more exaggerated degree. The shortest period gives the highest average concentration over the whole period. The question arose as to whether these differences were correlated with any variation in quality, and this experiment offered a good opportunity of investigation from the strictly comparable series of samples, regarding the effect of various periods of rest and tapping on the quality of the rubber. At the beginning of the second year, in May 1924, resting plots of all series of the experiment began to be tapped again on the same date, the only time when this happened during the course of the experiment. The rubber for each series for each day of the month of May was therefore kept separate and vulcanisation tests made, which are given in the second part of this paper.

Summary.

The yield of alternate period tapping either with half-month, one month, or two-month periods on a half of the circumference is equal and possibly slightly superior to that of daily tapping on one-third of the circumference.

Alternate period tapping causes fluctuations in the concentration of the latex which is highest immediately after the rest period and thereafter gradually falls. The highest average concentration for a complete tapping cycle is given by the shortest period

Part II.—The Effect of Alternate Periods of Tapping and Resting on the Quality of the Rubber.

It has been shown in Part I of this paper that alternations in the tapping and resting of rubber trees cause changes in the concentration of the latex and that the yield of dry rubber fluctuates according to the cycle of tapping and resting

It is also an established fact that the composition of the latex, apart from the rubber content, is affected by continued tapping and it is probable that such alteration in composition will affect the vulcanising capacity of the rubber. It has previously been shown for example that the yellow coloured latex from newly opened cuts

possesses vulcanising properties distinctly different from the white latex from normal tapping. It was therefore considered desirable to conduct vulcanisation tests on samples of rubber obtained from the field experiments on periodic tapping described in Part I. Similar experiments have been carried out by de Vries. ("Rubber van Periodentap" by O. de Vries, Archief voor de Rubberculture in Ned. Indie, Jaar 8, No. 10 October 1924).

Our conclusions from this investigation are similar to those of de Vries, except that in the present experiments, the fluctuations in the vulcanising capacity of the samples are greater than in the case of the samples examined by de Vries.

Vulcanisation Tests.—Samples of rubber were received and tested for each day of the month of May 1924 except the 1st. 2nd. 3rd. 5th. 6th. 7th. 16th. and 17th. The 1st. and 16th. were regular holidays and no tapping was done on these days. The 3rd was a rainy day and no tapping was done. Unfortunately the 5th. 6th. and 7th. were also holidays in this particular month, owing to the Lebaran Poewasa. Vulcanisation tests were however made on samples of May 2nd. at the Boenoet factory of the United States Rubber Plantations, Inc., and are summarised below. Vulcanisation tests carried out at Boenoet, using a Scott rubber testing machine (strip test pieces) with samples of the rubber of the first day's tapping (May 2nd) of each series gave the following results :—

—	Series 1. ½ month period.	Series 2. 1 month period.	Series 3. 2 month period.	Series 4. 4 month. period.	Series 5. 6 month. period.
Optimum time of cure at 140° C as judged by maximum product (tensile strength × elongation	2¼ hrs.	3 hrs.	3 hrs.	3¼ hrs.	3½ hrs.
Maximum tensile strength in lbs. per square inch.	2832	2923	3039	3226	3291.

In all cases the maximum tensile strength was given at the optimum cure, except in Series No. 1, where it was given at 3 hours. All the above figures are the average of four test pieces.

The optimum time of cure shows a regular progressive increase with length of the rest period, as also the maximum tensile strength, a feature which is not evident in samples of subsequent days.

Description of rubber samples:—The samples of rubber examined from these plots consisted of "first" latex, coagulated with acetic acid, milled into sheets and air-dried for a month. The air-dried sheets were then creped and dried in a vacuum dryer.

The plots from which samples were collected all started tapping on May 2nd, after rest periods varying with the series, and, with two exceptions, were tapped at the same height, all having had an equal number of tapping and rest periods. (A plots). The exceptions were the plots of Series No 4 which had two rest periods and only one tapping period, (B plots) and were tapped 4 ins higher than the others, and the "Series No 1" plots which changed to the B plots on the 17th. May and were thereafter 1 inch higher than the Series Nos. 2, 3 and 5 plots.

Experimental:—The samples were broken down and mixed with sulphur on the mixing rolls, without further washing and drying. The usual mix, ten parts of rubber to one part of sulphur, was adopted and the samples vulcanised at 140°C in a steam autoclave and tested on the Schopper machine 24 hours after vulcanization.

After determination of the optimum time of vulcanisation by reference to a standard stress-strain curve, further samples were vulcanized at the optimum time and twenty test rings were broken on the Schopper machine, in order to ascertain the variability in tensile strength. The "True Mean" of all the Breaking Loads and Elongations at Break were determined for each sample.

The "Standard Deviation" of each series of figures from the "True Mean" has also been calculated and, from these results, the "coefficient of variability" of each set of tensile strengths is re-"corded. On account of space, only the figures for variability of "Breaking Loads" are recorded in the table.

The results obtained are recorded in Table III and illustrated in Diagrams 1A, B, C, D, E and Diagram II. (1)

The irregularities in rate of cure, shown in Diagrams I, may be due to variation in maturation of the samples, which were all prepared originally in sheet form and dried before being creped.

Diagram II represents the idealised curves for rates of cure illustrated by the irregular curves in Diagram I. These curves have been drawn by averaging figures for pairs of days and smoothing any irregularities, in order to illustrate more clearly the general tendency in increase of rate of cure as influenced by the previous resting period in each series. In each series the curves show a marked depression at about the 14th day of tapping, again increasing up to the 18th day. This would appear to indicate the influence of some unknown factor, such as climatic conditions, during this period. These curves would have been of more interest, if a further series of samples could have been examined for the later stages of tapping in the case of the

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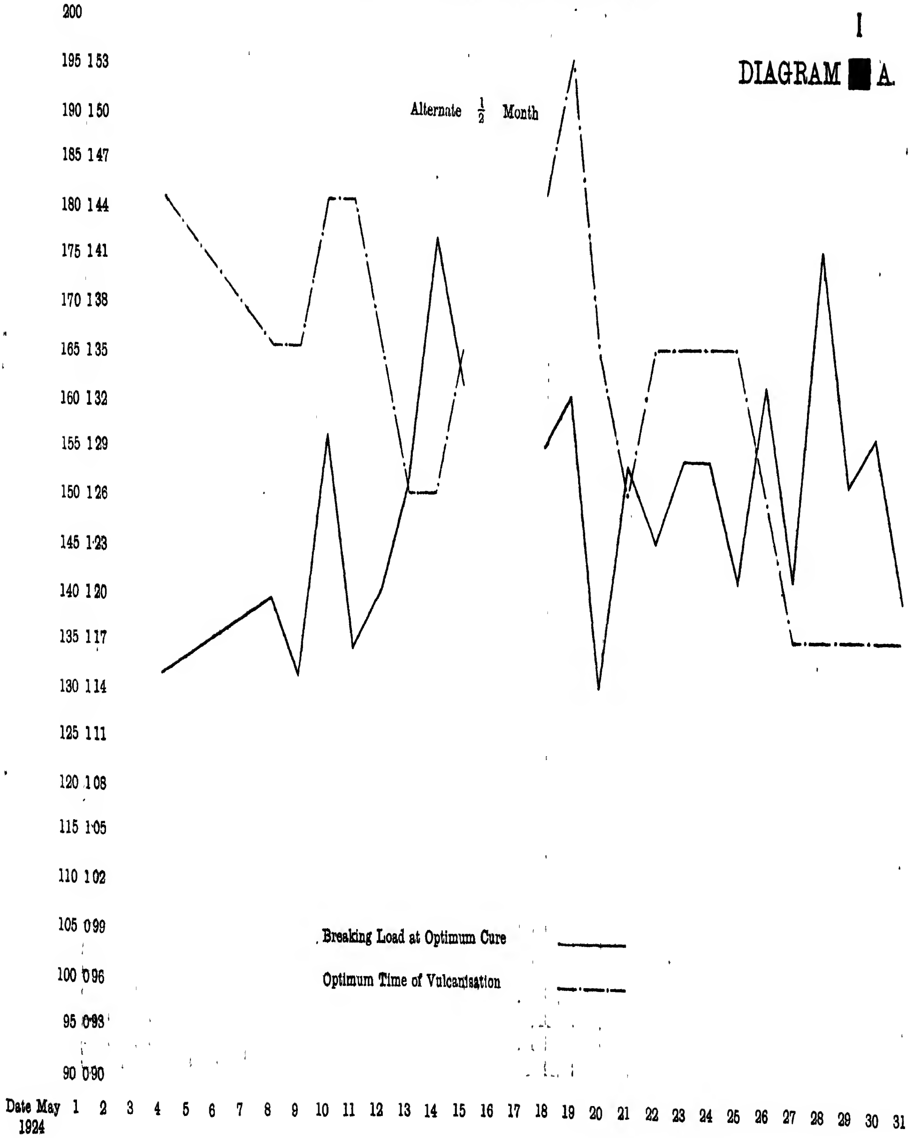
(1). The curves in Diagrams 1 B C D E should have a break on the 16th and 17th since the trees were not tapped and no samples were examined. The curves in Diagram I A have been separated, since they represent A and B plots.

Comparison of Rubber Samples Obtained from Trees Tapped Under Different Alternations of Tapping & Resting

Curves Showing Relationship Between Date of Tapping and Rate of Vulcanisation & Between Date of Tapping and Breaking Load



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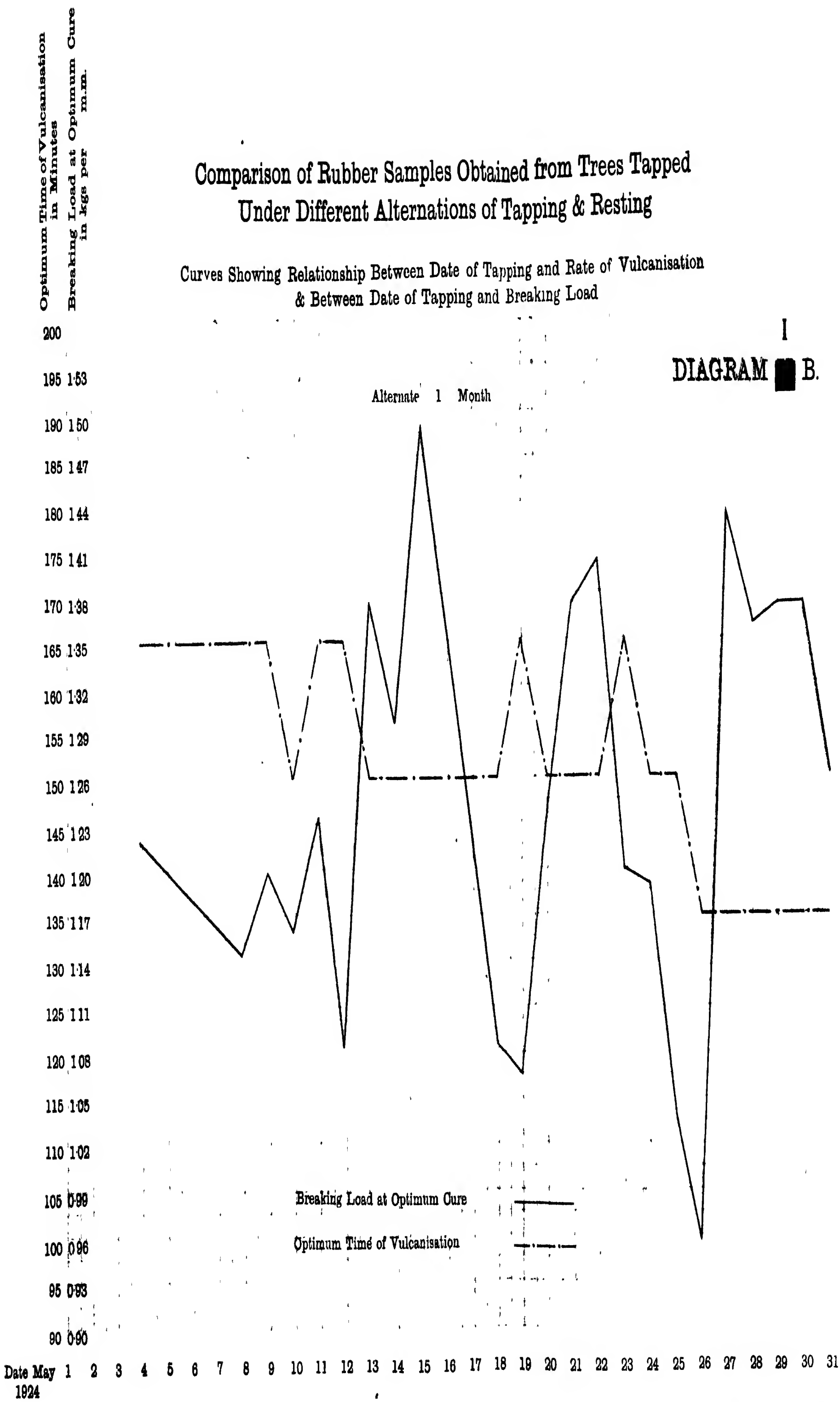
Comparison of Rubber Samples Obtained from Trees Tapped Under Different Alternations of Tapping & Resting

Curves Showing Relationship Between Date of Tapping and Rate of Vulcanisation & Between Date of Tapping and Breaking Load

DIAGRAM I B.



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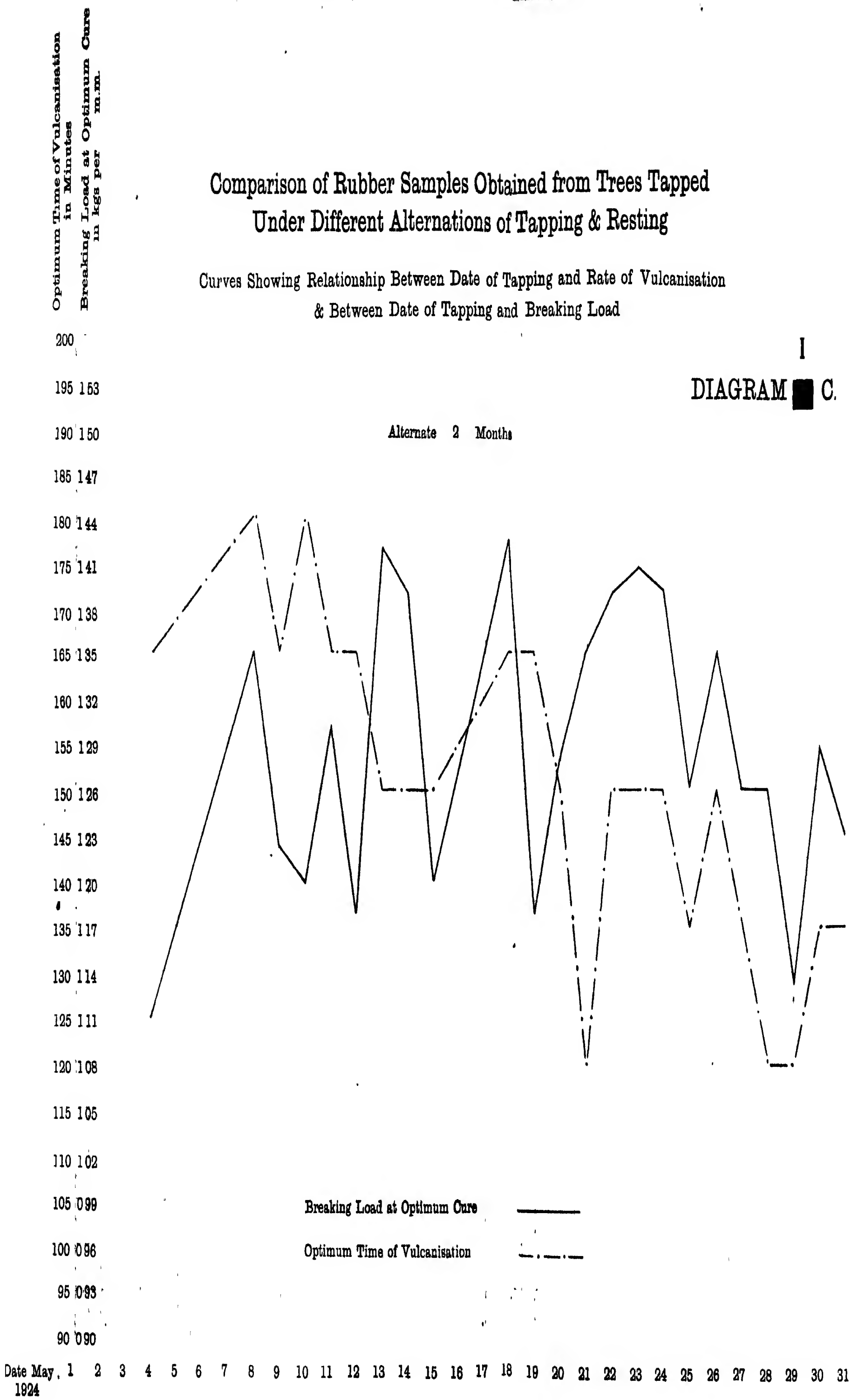
Comparison of Rubber Samples Obtained from Trees Tapped Under Different Alternations of Tapping & Resting

Curves Showing Relationship Between Date of Tapping and Rate of Vulcanisation & Between Date of Tapping and Breaking Load

I

DIAGRAM [redacted] C.



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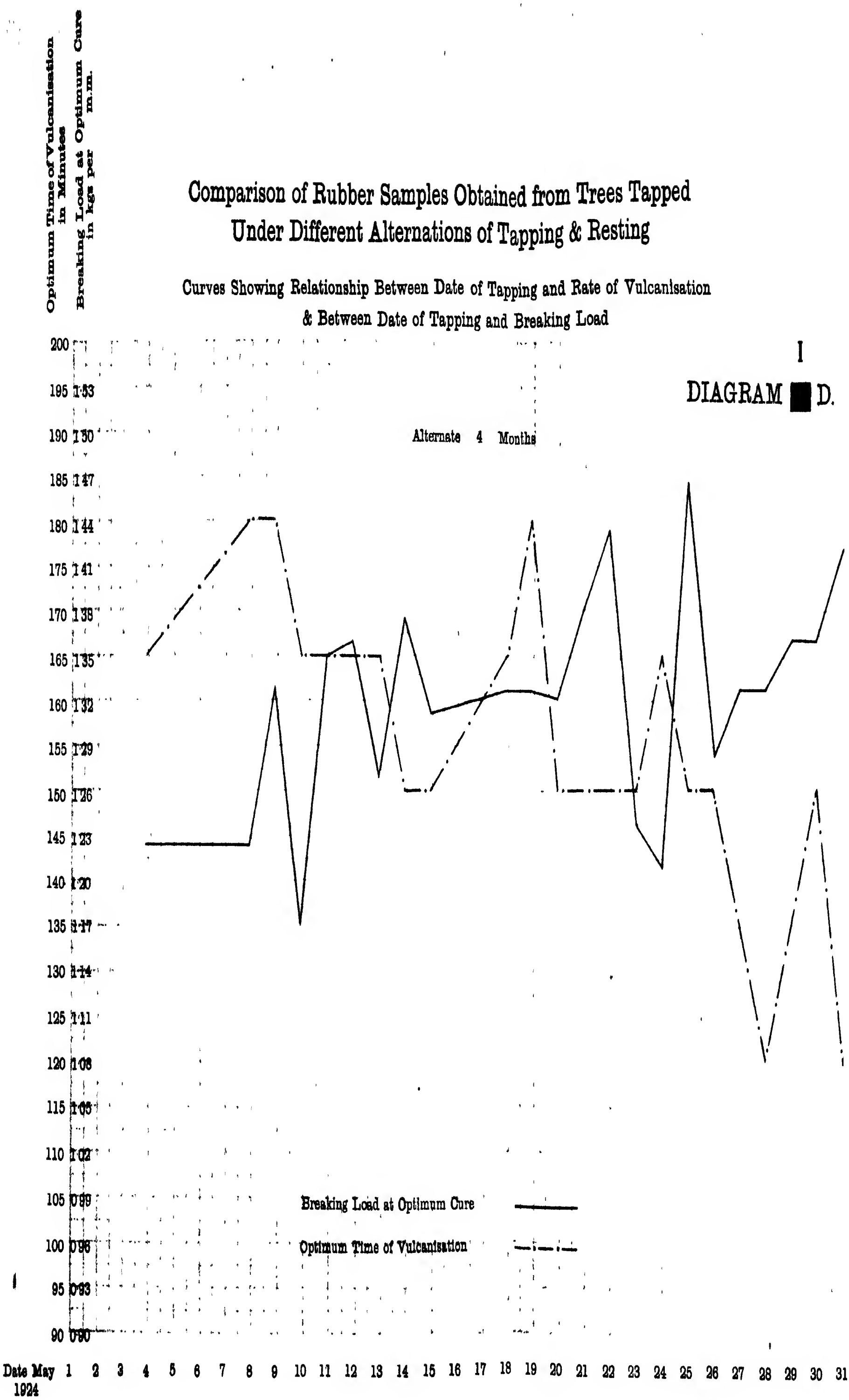
Comparison of Rubber Samples Obtained from Trees Tapped Under Different Alternations of Tapping & Resting

I
DIAGRAM [redacted] D.

Curves Showing Relationship Between Date of Tapping and Rate of Vulcanisation
& Between Date of Tapping and Breaking Load



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Comparison of Rubber Samples Obtained from Trees Tapped Under Different Alternations of Tapping & Resting

Curves Showing Relationship Between Date of Tapping and Rate of Vulcanisation & Between Date of Tapping and Breaking Load

I

DIAGRAM [redacted] E.

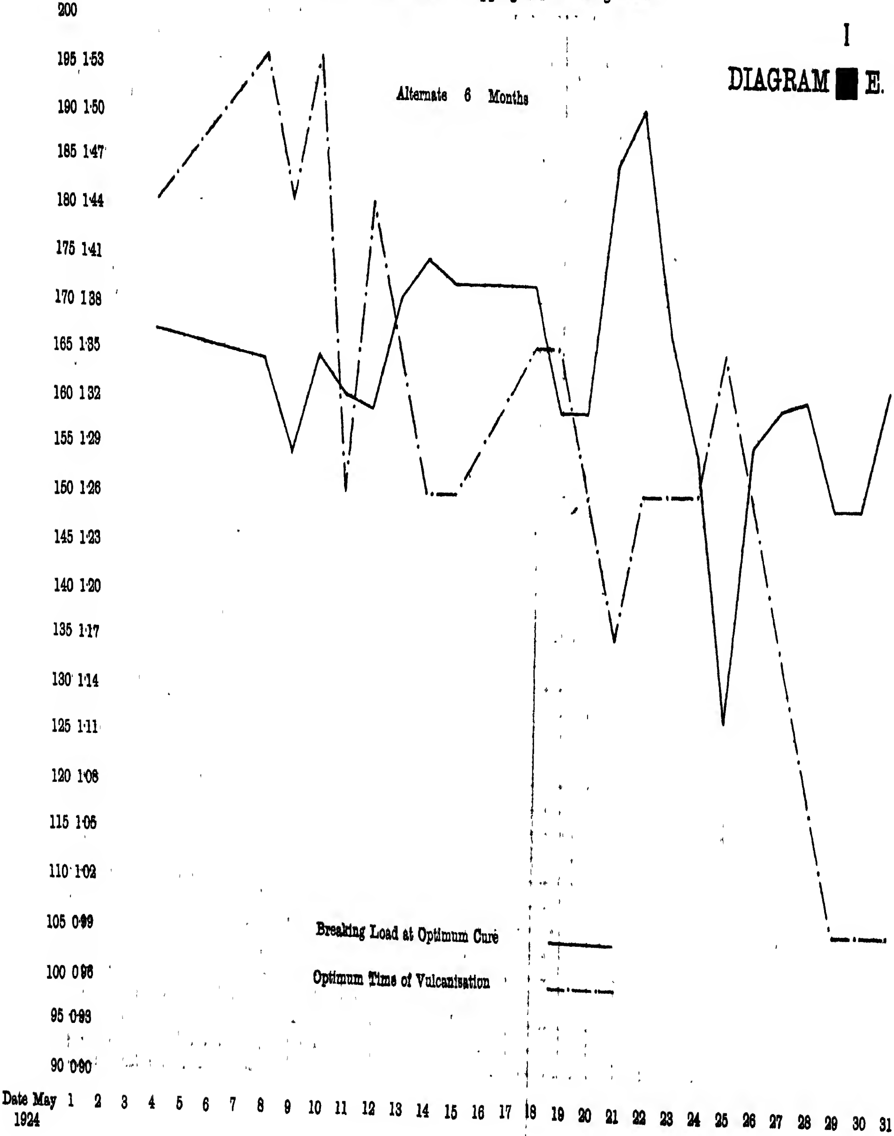

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Diagram II.

Comparison of Rubber Samples obtained from Trees Tapped with Different Intervals of Tapping and Resting.

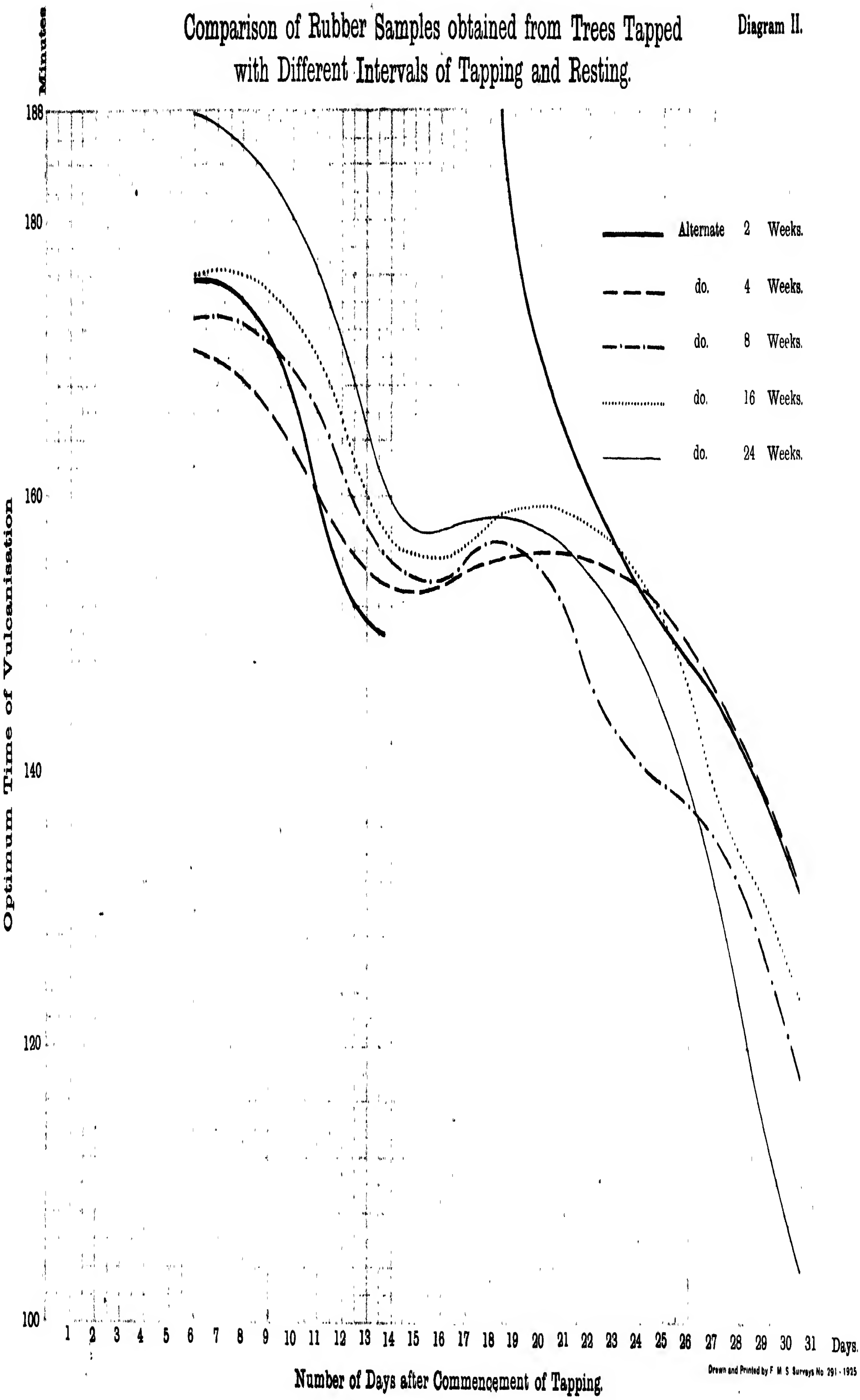

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TABLE III.

Comparison of Rubber Samples obtained from Trees tapped with different Intervals of Tapping and Resting.

Results Showing Optimum Times of Vulcanisation and Mean Breaking Loads.

Date of Tapping May 1924.	Plot 1A Alternate ½ month.			Plot 1B Alternate ½ month.			Plot 2A Alternate month.			Plot 3A Alternate 2 months.			Plot 4B Alternate 4 months.			Plot 5A Alternate 6 months.		
	Time of cure in minutes.	Mean B-L Kgs. per sq. M.M.	Coefficient of variability for Deviation on Mean of Breaking Loads.	Time of cure in minutes.	Mean B-L Kgs. per sq. M.M.	Coefficient of variability for Deviation on Mean of Breaking Loads.	Time of cure in minutes.	Mean B-L Kgs. per sq. M.M.	Coefficient of variability for Deviation on Mean of Breaking Loads.	Time of cure in minutes.	Mean B-L Kgs. per sq. M.M.	Coefficient of variability for Deviation on Mean of Breaking Loads.	Time of cure in minutes.	Mean B-L Kgs. per sq. M.M.	Coefficient of variability for Deviation on Mean of Breaking Loads.	Time of cure in minutes.	Mean B-L Kgs. per sq. M.M.	Coefficient of variability for Deviation on Mean of Breaking Loads.
4	180	1.15	22	..	..	..	165	1.22	23	165	1.11	7	165	1.22	5	180	1.36	11
8	165	1.19	13	...	...	..	180	1.15	5	180	1.35	6	180	1.22	5	195	1.34	9
9	165	1.15	15	...		...	165	1.20	9	165	1.22	5	180	1.33	27	180	1.28	9
10	180	1.30	3	.	..	.	150	1.16	6	180	1.20	11	165	1.17	7	195	1.34	6
11	180	1.16	13	..	..	...	165	1.24	5	165	1.30	6	165	1.35	3	150	1.32	6
12	165	1.20	9		.		165	1.09	9	165	1.18	4	165	1.36	9	180	1.31	5
13	150	1.27	13	...	..	...	150	1.37	8	150	1.41	5	165	1.27	19	165	1.38	3
14	150	1.41	5	..	..	.	150	1.30	9	150	1.39	0	150	1.37	11	150	1.40	5
15	150	1.33	6	.	.	..	150	1.49	5	150	1.20	30	150	1.31	3	150	1.39	5
18	..	..	...	180	1.29	6	150	1.09	18	165	1.42	3	165	1.33	7	165	1.39	6
19	...	..	..	195	1.32	8	165	1.07	21	165	1.18	39	180	1.33	11	165	1.31	5
20	...		..	165	1.14	2	150	1.24	14	150	1.28	6	150	1.32	14	150	1.31	6
21	.	..	..	150	1.28	3	150	1.37	2	120	1.35	10	150	1.38	4	135	1.46	4
22	..		..	165	1.23	13	150	1.39	7	150	1.39	9	150	1.43	2	150	1.50	6
23	..	...	.	165	1.28	7	165	1.20	31	150	1.40	3	150	1.24	33	150	1.36	54
24	...	.	..	165	1.28	7	150	1.19	21	150	1.39	6	165	1.21	22	150	1.25	11
25	.	..	...	165	1.21	20	150	1.04	34	135	1.26	5	150	1.46	2	165	1.12	34
26	...	.	..	150	1.33	5	135	0.95	42	150	1.35	7	150	1.28	21	150	1.29	13
27	...	...	...	135	1.21	12	135	1.43	6	135	1.26	16	135	1.33	7	135	1.31	31
28	...	...	.	135	1.41	3	135	1.36	8	120	1.26	5	120	1.35	5	120	1.32	18
29	...	.	..	135	1.27	11	135	1.37	7	135	1.13	9	135	1.36	5	105	1.25	8
30	...		..	135	1.30	3	135	1.37	6	135	1.29	6	150	1.36	0	105	1.25	15
31		.	...	135	1.19	6	135	1.26	8	135	1.23	22	120	1.42	3	105	1.33	5

2 months', 4 months', and 6 months' periods, in order to ascertain whether any further change occurred in the rate of cure. The rates of cure in the case of the 4 months' and 6 months' samples at the end of one month's tapping are comparatively rapid for sheet rubber and have not yet become constant. It is possible that the rates of cure may become slower again, since sheet from normal tapping usually has a slower rate of cure than that of the samples under investigation at the end of the one month during which samples were tested.

It will be noted from Table III that, in several instances, the "Mean Breaking Loads" show a high coefficient of variability.

We have found from other experiments that a coefficient of variability above 15 per cent. is abnormal and that the usual figure is below 10 per cent.

For this reason, tests were repeated on these samples, but the coefficient of variability still remained abnormally high.

It is not possible at present to offer any explanation for these large deviations.

CONCLUSIONS.

From the results recorded above, the principal conclusion which can be drawn is that the alternation of tapping and resting affects the time of vulcanisation of the rubber.

The rubber obtained from trees tapped after a long period of rest has, during the early stages of renewal of tapping, a very slow rate of vulcanisation, which settles down to a constant and more rapid rate after about three to four weeks.

The irregularity of the tensile figures do not permit any definite conclusions to be drawn as to the actual tensile quality of the rubber, which appears not to be affected to any marked extent.

The results in respect of the effect of periodic tapping systems on the rate of vulcanization and tensile strength of the rubber confirm results published by de Vries and Spoon (Ref. Mededeeling van het Central Rubber Station No. 42, 1924).

According to de Vries' experiments, the rates of vulcanisation of rubber from trees tapped after resting periods of one month or less all fall within the "normal" region of cure (deviations up to 20 per cent of average) and most of them within the "uniform" region (deviations up to 10 per cent of the average.)

In our experiments however the rate of vulcanisation of the samples from the trees immediately after the short periods of rest, viz., ½ month and 1 month, is as slow as for the longer periods of rest of 2 months and 4 months, but not quite as slow as for the resting period of 6 months. The final rate of vulcanization of the rubber from the trees rested for 4 months and 6 months is also faster than in the case of the shorter resting period, so that the total variation is greater for the longer resting periods.

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THE PADI FLY (*LEPTOCORISA* SPP.) IN KUALA PILAH DISTRICT.

BY W. H. BARNES AND F. W. SOUTH.

GENERAL.

THE "Padi Fly" or "Rice Sapper" is the popular name given to the various species of *Leptocorisa* which, both as nymphs and adults, suck the juices of developing grains of padi when they are in the milky stage. When present in large numbers these insects are capable of doing serious damage, as the following account shows. Five different species have been recorded from Malaya, Leptocorisa varicornis, F.; L. acuta, Thunbg; L. lepida, Bredd; L. Corbetti, China and L. costalis, H. S., all of which are known to Malays as "Pianggang" or "Chenangau." These insects are capable of living on certain grasses other than padi and on some sedges. Corbett succeeded in breeding *Leptocorisa*, probably *costalis*, through its complete life cycle from egg to adult on seven different species of grasses. In his article he gives a summary of the various species of grasses and sedges on which these insects have been recorded as feeding in different parts of the Tropics (M.A.J. Vol. XI. p. 213).

Numerous notes in the Malayan Agricultural Journal show that the Padi Fly is very generally distributed throughout Malaya. It is to be found in the majority of padi fields each year, though in such small numbers as to do little damage. Almost every season, however, it occurs sporadically in larger numbers in a few localities and destroys an appreciable portion of the crop.

HISTORY OF THE PEST IN KUALA PILAH DISTRICT IN 1924 AND 1925.

During the padi harvest early in 1924 there was a serious outbreak of these pests around Inas and Johol in Kuala Pilah district of the Negri Sembilan. The insects were present in such large numbers on certain of the padi fields (Sawah) near Inas that the crop was almost entirely destroyed and the Malay owners of these fields, who usually grow sufficient padi to supply their wants, were forced to purchase rice six weeks after harvest. Several fields around Johol were also badly infected and the crops from them were in consequence very small.

After harvest the insects were found resting on Resam (*Gleichenia linearis*), Kedudok (*Melastoma malabathricum*) Lantana and grasses, but in no case were they observed to be feeding nor were eggs found. The impression was obtained that the last brood of insects which reached maturity in the 1923-24 season remained alive without laying eggs until the following season's padi was in the right stage to provide them with a large supply of suitable food, when they again commenced to lay eggs.

In most fields in Kuala Pilah District several different varieties of padi with different maturation periods are planted, and planting is not all done at the same time, but may be continued over five or six weeks. Consequently there is a succession of plots of padi in the right stage to provide food for the padi fly and to support two consecutive generations. The natural result is, that, if left unchecked, these insects increase in numbers rapidly and completely destroy the later ripening plots.

During the intercrop season in 1924 efforts were made to find some substance which was attractive to the padi fly. Various essences and scents were used without success. Rotten meat was found to be slightly attractive but would not attract the insects from any distance.

It was known, however, that during the 1923—24 season a Malay at Inas had made a sticky mixture, such as is used for catching birds, and had caught a number of the adult insects by spreading the mixture on a piece of net attached to a bamboo and by waving the net over the tops of his padi plants. When thus disturbed the insects flew and were caught on the sticky mixture. By continually using this method he managed to preserve about one half of the crop usually obtained from his land, whereas his neighbours who did nothing lost practically all their crop. This method, or simple variations of it, was successfully used to control the attacks of these insects in the following season of 1924-25.

Early in the 1924-25 padi season the insects appeared in even larger numbers than in the previous season, at Inas, Johol, Ayer Mawang, Selaru, Ulu Pilah, Peraku and Gemaylang, all of which localities are in Kuala Pilah District. It was at once realised that unless they were destroyed before breeding there would be no padi in these areas.

It was observed that where the pest was plentiful individual owners working alone could not successfully control it. Definite organisation of all the workers who could be made available was clearly necessary. To achieve this the District Officer and his Penghulus and Malay Assistants co-operated with the Agricultural Field Officer, Negri Sembilan, and the local Malay Officers of his staff. The Forest Department assisted by supplying free a quantity of Keruing oil and by giving passes to Malays to obtain the necessary gums to make the sticky mixture.

The Agricultural Pests Enactment does not empower an Inspector to order anyone to work on land other than his own. It could not, therefore, be used to obtain the necessary workers. However, Land Rule Clause 23 B (iii) empowers the District Officers in Negri Sembilan to order any work for the common benefit. This rule was promptly applied and the whole population adjoining each sawah was assembled to combat the pest. The workers were organised into parties which were placed in charge of Malay Assistants, Penghulus and local Malay Officers of the Agricultural Department, all of who did much hard work in supervising the destruction of the pest and seeing that it was thoroughly done.

Methods Employed.

As already stated the principal method employed consisted of collecting the insects on various simple pieces of apparatus on which was spread a sticky mixture to which they adhered when touched by it.

It was most desirable, in order to avoid heavy expenditure, to use a method of destroying "padi flies" which required only such materials as the Malays could easily obtain for themselves, if possible free of any cost beyond the labour of obtaining and preparing them.

The method already referred to fulfilled this condition. The materials used for making the sticky substance were Keruing oil, presented free of charge by the Forest Department, mixed with either Jelutong, Getah Trap or Getah Grip which wild rubbers the Malays could obtain for themselves in the jungle. Jelutong was generally preferred.

When large quantities of adults were found the most effective apparatus on which to spread the sticky mixture consisted of a piece of old casting net 2 feet long by 1 foot wide which was stretched at one end of a bamboo 6 or 8 feet long and was waved among the flying insects and over the tops of flowering padi on which they had settled.

As the numbers of the insects decreased more handy implements were used. One form of implement was made from the leaf stalk and attached leaflet midribs of the Bertam palm (*Eugeissona tristis*). The leaf tissue was removed from the midribs of the leaflets and the midribs themselves were smeared with the sticky mixture. Another form consisted of a rough racquet of split bamboo. This was made by attaching thin pieces of split bamboo to the end of a stick in such a manner that they radiated like the ribs of a fan. Across these ribs thin strips of rattan were tied. The racquet was then smeared with the adhesive mixture. For collecting a few individual adults that might have escaped earlier collecting operations and for catching nymphs light wands or twigs were used, often by children. A length of about 6 inches at the end of each wand was dipped in the mixture. After being used for an hour or two, these wands had the appearance of a bullrush flower, the swollen part being composed of dead padi flies.

Where the nymphs were found in large numbers they were collected by shaking the infested heads of padi over pans of water mixed either with the juice of limes and wood ashes or with a little kerosene oil. The insects fell into the pans and were killed. The pans themselves were made by cutting kerosene tins in half lengthways.

The eggs, which were not found until the majority of the adults had been destroyed, were collected and destroyed. In this connection it should be remembered that the eggs are parasitised by hymenopterous insects. It is therefore preferable not to destroy the eggs but to put the portions of the leaves on which they are laid into cigarette tins and to place the tins in a dish containing a little water and

kerosene oil. When the nymphs hatch out they cannot escape, since they are unable to fly and on leaving the tins fall into the water and are killed. The egg parasites, however, emerge as adult flies and escape to continue their useful work.

The fact that the mature padi fly is not a strong flier and only travels a dozen yards or so before alighting is of assistance in using the described method of control, since those that escape collection on one occasion are found again at only a short distance. That the immature insect when disturbed falls to the ground and hides is also of assistance as is the fact that both nymphs and adults are not too easily disturbed.

Results Obtained.

The results obtained from this organised cooperative action were quite satisfactory. In all localities where the insects were reported in good time and where work could in consequence be undertaken promptly, very little damage was done by this pest and average padi crops were obtained. The following table shows the effect of the control measures. The crops are recorded in gantangs (gallons) per acre.

Locality.	Crop. 1923	Crop. 1924
Johol ...	104	188
Pilah ...	165	142
Sri Menanti ...	148	136
Ampang Tinggi ...	205	115

Johol crops were badly infected in both years. In 1923 no attempt was made to deal with the pest, in 1924 it was dealt with fairly thoroughly.

Pilah and Sri Menanti mukims had very few of the insects in 1923. In 1924 the attack was severe but was controlled,

Ampang Tinggi was fairly free from the pest in 1923. In 1924 infestation was severe but only part of the infested area was reported in time to be dealt with thoroughly.

The total area infested with padi fly and treated in the 1924-25 season was approximately 8,600 acres. Had nothing been done it is very probable that almost the entire crop from this area would have been destroyed.

Intercrop Season 1925.

Work has been continued on the control of the padi fly since the harvest of 1925. Malays have been encouraged to cut down and burn all grasses on the edges of padi fields to deprive the surviving insects of food. Swarms have been searched for and have been found in

weedy rubber holdings, or patches of jungle, where they were again resting on Resam and Kedudok. These swarms have mostly been destroyed when found by the method used in the padi fields.

It is of interest to note that in no case since the harvest have either eggs or nymphs been found, only mature insects. One swarm has remained in one locality for four months and has been under frequent observation but has not yet been known to produce eggs.

It is worthy of record that some of the insects in this last mentioned swarm were attacked by what appears to be a parasitic fungus, identified by the Mycologist as a species of *Hirsutella*. The number of insects attacked was however, small and the fungus cannot be regarded as exercising at present any effective control.

Conclusion.

1. Cooperative and organised use of an easily applied and inexpensive method of catching these insects provides an effective control.

2. It is important that all the padi in any one sawah (padi field) should come into flower as nearly as possible at the same time. This point is understood by Malays. It can be attained in permanently irrigated areas, where it should be enforced. It is, however, unattainable where water supplies are irregular.

3. It is important to destroy the padi fly when it first appears in small numbers.

4. It is important to clean the edges of padi fields from grass, so that the insects have no supply of food near the sawahs after the padi harvest.

5. After harvest swarms found in rubber holdings or in the jungle or elsewhere should be destroyed.

Received for publication 10th September 1925.

THE EXPERIMENTAL CULTIVATION OF YAMS AT THE GOVERNMENT PLANTATION, SERDANG.

By J. N. Milsum and E. A. Curtler.

A collection of edible yams was received from the Botanic Gardens, Singapore, early in 1924. From this material two crops have been raised but as the results obtained from the first crop were from a few plants only, they are not included in the present paper. The second crop, harvested in October 1925, gave an average calculated yield of over seven tons of roots per acre for the whole collection of twenty-five races. Six races returned a calculated yield of over ten tons of roots per acre, while one race (No. 48) gave almost fourteen tons.

The yam is a starchy food and in certain parts of the tropics supplies the place of the potato. In the Malay Peninsula among the Chinese and to a less extent other nationalities, the sweet potato usually take this place. Europeans, however, are very conservative in the matter of food and so far rarely eat either yams or sweet potatoes. Yams might well be included in the diet of persons living in the Peninsula as they are not only very palatable, when properly cooked, but are similar in food value to the potato.

Races.

The races received from the Singapore Gardens were from the rich collection formed by Mr. I. H. Burkill, late Director of Gardens, Straits Settlements. Reports regarding the experimental cultivation of these yams in Singapore have appeared in the Gardens' Bulletin, S. S., during the past ten years. In many instances the roots have been illustrated and for the purpose of reference the registration number adopted by the Botanic Gardens, Singapore, is maintained.

The collection grown at Serdang consists of races of two species of *Dioscorea* i.e., *D. alata*, Linn, the greater yam, and *D. esculenta*, Burk., the lesser yam.

Dioscorea alata is a strong growing climber with quadrangular winged stems which twine to the right. The leaves are large, glabrous, and sharply angled. The tubers are frequently large, variously shaped and usually dark brown in colour. The greater yam is a native of the eastern tropics and has been known from the Indian Ocean to the Pacific for centuries. It is allied closely to some of the wild yams of Eastern Tropical Asia, but shows signs of considerable selection under cultivation.

Dioscorea esculenta is a thorny climber. The leaves are kidney-shaped at the base, pointed at the tip and somewhat hairy. The tubers are relatively small but produced in quantity. They are readily distinguished on account of their spiny persistent roots.

This species is less widely known than *D. alata* and its distribution more confined.

Description of Races Cultivated.

Dioscorea alata.

No. 10.—Origin Luzon, Philippine Islands. (No. 1057). Native name 'Tugui.' finger-shaped. Tuber medium size, unbranched. Sap magenta under the skin, flesh white. Illustrated Gard. Bull. (1). Vol. I, No. 9, fig. 2 on p. 299.

No. 28.—Origin College of Agriculture, Philippine Islands (No. 1095). Native name 'Tumuktok.' Tuber medium size, curved, flattened and somewhat fingered. Flesh white, with bright magenta sap under the skin. The elongated tubers curve in the soil. Illustrated Gard. Bull. Vol. I, No. 9, fig. I on p. 301 and Nos. 11—12, plate V, also Vol. III, No. 2, plate iii.

No. 30.—Origin College of Agriculture, Philippine Islands. (No. 960), Native name 'Ubag.' Tuber medium size, long, unbranched, with a tendency to produce twin tubers. Good for table (Burkill). Flesh white, with slight magenta sap under the skin. Illustrated Gard. Bull. Vol. I, No. 9, fig. 2 on p. 301.

No. 44 —Origin Bureau of Agriculture, Manila, P. I. (No. 1025). Name 'Ubi, red.' Tuber medium size, long, unbranched. Flesh white, magenta sap below the skin. Illustrated Gard. Bull. Vol. II, No. 2, plate ii.

No. 48. --Origin Philippine Islands (No. 2712). Tuber large branched. Flesh white, slight magenta sap under the skin.

No. 50.—Origin Bureau of Agriculture, Manila, P. I. Name 'White Bohol,' 'White Manila Yam.' (No. 824), Tuber large, lobed, somewhat flattened and branching. Skin very clean. Flesh white, which does not oxidise on exposure to the air, no magenta sap.

Illustrated Gard. Bull. Vol. II, No. 5, p. 158. Mr. I. H. Burkill refers here to a particularly large tuber of this race raised in Singapore. The tuber illustrated weighed 29 lbs. after being nine months in the ground. The circumference of the yam is shown as fifty-eight inches.

No. 64.—Origin Philippine Islands (No. 1040). Tuber large, lobed. Flesh white, turning brown quickly when exposed to the air, no magenta sap. A good table yam (Burkill).

No. 66.—Origin Philpppine Islands. Name 'Ubi White'. (No. 1046). Tuber large, lobed, produced in cluster and descends deeply. Flesh white, turning brown when exposed to the air, no magenta sap.

No. 72.—Origin College of Agriculture, Philippine Islands. Name 'Sinawang pulo yam'. (No. 955). Tuber medium size, long, unbranched. Skin rather rooty. Flesh white. Sap magenta under the skin. A good table yam (Burkill). Illustrated Gard. Bull. Vol. I, Nos. 11—12, plate vi, and Vol. II, No. 2, plate iv.

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(1) Gard. Bull. refers to the Gardens' Bulletin, Straits Settlements.

No. 76.—Origin College of Agriculture, Philippine Islands. Name 'Sinanto'. (No. 958). Stem of plant prickly. Tuber large, lumpy and bulky, irregular in outline. Flesh ivory yellow, no magenta sap. Illustrated Gard. Bull. Vol. I, Nos. 11—12, plate ii, and Vol. II, No. 2, plate i and ii.

No. 100.—Origin Saigon. Name 'Khoai noc trang.' Tuber large, branched, somewhat flattened. Flesh white, magenta sap under the skin. A good table yam (Burkill).

No. 408.—Origin Saigon. Selected from 'Khoai Siam'. No. 98 in 1917. Tuber large, branched. Flesh white, firm, slight magenta sap under the skin. A distinctly late race (Burkill).

No. 410.—Origin Manila, P. I. Selected from No. 52 in 1917. Tuber medium size, unbranched. Flesh yellow, no magenta sap.

No. 498.—Origin Singapore. Tuber globular, branched. Flesh magenta with deeper coloured sap below the skin.

No. 510.—Origin Tahiti, Native name 'Ufi mene-mene'. Tuber globular. Flesh white with no magenta sap Illustrated Gard. Bull. Vol. III, Nos 1—3, plate opposite p. 4. Nos. 1 and 5.

No. 512.—Origin Tahiti, Native Name 'Ufi opura'. Tuber medium size, oblong. Flesh white, with no magenta sap. A good edible yam (Burkill). Illustrated Gard. Bull. Vol III, Nos. 1—3, plate opposite p. 4, No. 10.

No. 516.—Origin Tahiti. Native name 'Ufi paparatea'. Tuber long, unbranched, deep growing. Flesh white with slight magenta sap below the skin. A good yielder (Burkill). Illustrated Gard. Bull. Vol. III, Nos. 1—3, plate opposite p. 4. No. 2.

No. 518.—Origin Tahiti. Native name 'Ufi tiauu' Tuber long, unbranched. Flesh white with slight magenta sap below the skin. A good yielder (Burkill). Illustrated Gard. Bull. Vol. III, Nos. I—3, plate opposite p. 4 No. 9.

No. 530.—Origin Brunei. Tuber oval, short, lobes divergent. Flesh white, deep magenta sap below the skin. Illustrated Gard. Bull. Vol. III, Nos. 1—3, plate opposite p. 6, lower figure.

No. 548.—Origin Malacca. Tuber small, globular, produced in quantity. Flesh magenta with deeper coloured sap below the skin.

No. 622.—Origin Grik, Perak. 'Ubi junjong merah.' Tuber medium size, half-long, many roots persistent. Flesh magenta-purple with deeper coloured sap below the skin.

No. 632.—Origin Batu Gajah, Perak. Tuber long, branched, many roots persistent. Flesh yellow with magenta sap below the skin.

Dioscorea esculenta.

No. 270.—Origin Bureau of Agriculture, Philippine Islands. (No 1063). Tuber short, branched. Flesh white. Heavy yielder, diffuse (Burkill).

No. 288.—Origin Saigon. Native name 'Khoai tu-bua.' Tuber short, branched. Flesh white. Good flavour, heavy yielder (Burkill.) Illustrated Gard. Bull. Vol. 1. Nos. 11—12, plate vii, lower figure.

No. 296.—Origin Akola, India. Native name 'Goradu' (No. 33346.) Tuber short, branched. Flesh white. Taste just sweet, fair yielder (Burkill.)

Cultivation.

The most suitable soil for yam cultivation is a sandy loam with a fair amount of humus. The plants, however, grow satisfactorily in clay or sandy soils. Stiff, heavy soils are unsuitable as the tubers are unable to develop properly The yam being a deep-rooted crop requires deep cultivation and thorough drainage to obtain high yields. The plants are best grown on ridges as in the case of sweet potatoes. In the present trials the ridges were placed 4 feet apart and the sets planted 2 feet apart in the ridges. The application of a dressing of well-rotted cattle manure results in more vigorous growth and increased yield of tubers.

Yams are propagated from sets taken from the mature tubers. The upper woody part of the yam, or that nearest the stem, is most ready to sprout and the basal part of the tuber least. (I) The former should therefore be used as sets. The length of time that elapses between planting the sets and the appearance of the shoots depends to a great extent upon the condition of the tubers. Tubers kept in a dark place for any length of time after lifting throw out strong shoots which grow rapidly, obtaining their nourishment from the tuber. In the present experiments the average period between planting the sets and commencement of growth was 22 days in the case of races of *D. alata* and 29 days with *D. esculenta.*

Periodical weeding should be attended to and the soil slightly stirred during dry weather to prevent excessive evaporation of moisture.

To obtain the best development of the roots, the plants should be staked with strong poles about ten feet in length. Experiments conducted in the West Indies show that in every case there was a large increase in yield from staked yams as compared with the unstaked ones, amounting to more than 100 per cent on the total yield (1).

Harvesting.

The maturity of the crop is indicated by the drying up of the leaves and general cessation of growth of the plant. The crop takes from nine to ten months to mature. Considerable care is necessary, in the case of the deep-rooting races, to lift the tubers without injuring them. Owing to this cause, the yam is more expensive to harvest than other root crops as usually individual digging is necessary.

(I) Gardens' Bulletin. S.S., Vol. I, No. 9 p 306. 'Different parts of the tubers of *Dioscorea alata* sprout at different rates.'

Yield.

The area planted in these trials was one chain wide, which allowed of 33 sets being planted in a row. In calculating the yields per acre, the weight of tubers obtained from each row are multiplied by 165 i. e., the actual number of rows at 4 feet apart which go to make up an acre. In a number of instances it was not possible to plant up an entire row with one race and the results in these cases are naturally less reliable than when an entire row of one race was harvested. These races are as follows:—Nos. 10, 28, 30, 498, 510, 580, 548, 622, 632. The results cannot be regarded as comparative but give an indication of what crops may be expected from yams grown under average conditions.

The weights recorded are those of the tubers after being thoroughly cleaned of all soil.

Table I.

The Greater Yam. *Dioscorea alata.*

Race Registration No.	Number of sets planted.	Actual yield lbs.	Calculated yield per acre lbs.
10	6	27	24,500
28	9	17	10,340
30	11	62	30,690
44	33	120	19,800
48	33	188	31,020
50	33	42	6,930
64	33	120	19,800
66	33	119	19,630
72	33	62	10,230
76	33	130	21,450
100	33	55	9,070
408	33	172	28,380
410	33	45	7,420
498	22	58	14,350
510	7	8	6,220
512	33	42	6,930
516	33	37	6,100
518	33	96	15,840
530	20	53	14,420
548	6	8	7,220
622	22	100	24,750
632	8	16	10,890

Average calculated yield per acre ... 7 tons
Average weight of tubers from each set ... 3 lbs.

(1) Gardens' Bulletin, S. S., Vol. II, No. 8, p. 301. 'Staking Yams'.

Table II.

The Lesser Yam. *Dioscorea esculenta.*

Race Registration No.	Number of sets. planted.	Actual yield lbs.	Calculated yield per acre lbs.
270	33	82	13,530
288	33	152	25,080
296	33	86	14,190

Average calculated yield per acre ... 7·8 tons.
Average weight of tubers from each set ... 3 lbs.

Table III.

A good tuber of each race was weighed and the results are shown in the following table.

Race Registration No.	Species.	Weight of tubers. lbs.	ozs.
10	*Dioscorea alata*	2	4
28	" "	1	14
30	" "	5	8
44	" "	6	4
48	" "	15	—
50	" "	3	12
64	" "	9	8
66	" "	11	—
72	" "	2	8
76	" "	7	4
100	" "	7	6
408	" "	10	8
410	" "	2	8
498	" "	5	—
510	" "	1	8
512	" "	4	8
516	" "	6	12
518	" "	4	4
530	" "	2	12
548	" "	1	4
622	" "	3	6
632	" "	4	—
270	*Dioscorea esculenta*	1	2
288	" "	1	10
296	" "		8

SUMMARY.

Twenty-five races of yams are enumerated and the tubers described briefly.

2 The cultivation of the crop is outlined.

3 The yields obtained from these races under cultivation at Serdang are recorded. The crop was nine months in the land and yielded a calculated average return of 7 tons of tubers per acre.

Preparation of Yams for the Table.

In the East the proper preparation of yams for the table is not generally understood therefore the following recipes are reproduced from one of the publications of the Imperial Department of Agriculture for the British West Indies.

Roasted Yams.—Lay a yam before the grates of the stove or in the oven, turning it occasionally until cooked, scrape off the outer skin, cut into pieces or mash with butter; serve hot.

Baked Yams.—Pare a yam, put it in the oven and bake until soft, take it out of the skin, mash with butter, put back into the skin; cut in piece and serve hot.

Boiled Yams.—Pare a yam, put it into boiling water, cook until tender; serve whole.

Yam Chips.—Pare a yam and boil until tender, cut it in chips; fry in boiling lard and serve hot.

Yam Rice.—Pare a yam and boil until tender; press through a colander into a hot dish; shaking the colander lightly every few seconds, to cause the yam to fall off in short grains like rice; serve very hot.

Yam Rissoles.—Pare, boil and mash a yam with pepper and salt, and if liked, a little minced parsley; shape into rissoles, cover with egg and bread crumbs, and fry until a light brown.

Yam Border.—Pare, boil and mash a fairshaped yam, about two pounds in weight, and add to it two tablespoonsful of butter, half a cup of boiling milk, one tablespoonful of salt, the yolk of two eggs (well beaten); beat the mixture until very light; butter a border mould, pack the yam in it, and let it stand for eight minutes, beat the whites of the eggs to a froth, add salt, turn out the yam, cover with the whites and put in an oven to brown; take from oven and fill the centre with meat or flesh heated in a sauce.

Yam au Choux.—Take one pound of boiled yam, one boiled cabbage, two teaspoonsful of cream one ounce of butter, with salt and pepper to taste; rub the yam and cabbage through a wire sieve, mix

together with butter, cream and seasoning; pile upon a dish, and serve with fried croutons of bread around. Serve very hot.

Porcupine Yam.—Take two pounds of yam, boil and mash with one egg and salt to taste; shape and roll in beaten egg and vermicelli; fry. Serve hot with parsley.

Yam Fritters.—Pare and boil half a pound of yam until soft, beat lightly with a fork; beat the yolks of four and the white of three eggs, and two spoonsful of cream, two tablespoonsful of wine, one dessert-spoonful of lemon juice and half a teaspoonful of grated nutmeg; beat all altogether until extremely light, put plenty of lard into a frying pan and drop a tablespoonful of the butter at a time into it, and fry the fritters to a nice brown. Serve with wine sauce (served separately), or only sprinkle powdered sugar over them.

Yam Pudding.—Take half a pound of yam, two eggs, one lemon, twoo unces of butter, two ounces of sugar; pare and boil the yam, and rub it through a sieve while hot; beat the butter and the yam together, and allow the whole to cool; break the eggs and separate the yolks from the whites; beat the yolks until light, and add sugar, the juice of a lemon as well as the grated rind, and the yam. Whisk the whites to a stiff froth and stir lightly in before baking; put in a well buttered dish and bake in a brisk oven for twenty minutes.

Yam en Brun.—Cut up one pound of yam already boiled, and fry to a light brown; sprinkle thickly with chopped parsley and shalat or mushroom, pepper, salt and lime juice; serve very hot.

Received for publication 5th November 1925.

REPORT ON THE RAT CAMPAIGN IN KRIAN BETWEEN THE PERIOD MAY 15TH & END OF AUGUST, 1925.

By Frank Birkinshaw.

A. Resume of Experience Gained in the six Months of the Campaign over a Restricted Area.

ONE of the objects of the Rat Campaign begun in 1924 over a restricted area in Krian was to gain information as to the most effective way of dealing with the rat problem in padi fields. (M. A. J. Vol. XIII No. 6 p. 168).

2. Experience gained in this preliminary Campaign showed that the most effective methods of rat destruction under the circumstances were trapping by Malays and organised hunting by Tamil coolies. School children materially assisted in the trapping. Organised hunting on any large scale was entirely confined to P.W.D. coolies, the hunts being organised by the P.W.D. This Department rendered great assistance in this way. No organised hunting was done by Malays although both European Officers made attempts to get it commenced on a systematic basis. Poison baits never became popular. The usefulness of poison gas in holes was found to be extremely limited as holes are not numerous and occupy much time in finding: even then only a proportion of the holes were found to be occupied.

B. Inauguration of an Organisation for an Extended Campaign.

The results of the Campaign over the restricted area were considered sufficiently good to warrant an extension of the Campaign to the whole of Krian District for the next season. This extended Campaign was commenced on May 15th 1925.

2. The organisation consists of one European Officer (Rat Destruction Officer) and five Malay Officers. The Rat Destruction Officer was Mr. Lindsay Vears up to July 4th (when he resigned) and Mr. G. S. Sutherland (who is still in charge) from July 9th.

3. The Malay Officers are in charge of defined areas. Their duties are to visit Ketuas regularly and to check the number of tails tendered by them and by others, reporting totals to the Rat Destruction Officer on his weekly visits. Each officer makes a regular tour of the area allotted him, reports to the Rat Destruction Officer when and where fresh traps are needed, if poisons are required and assists the Rat Destruction Officer generally in the encouragement of rat destruction, both as regards the cultivators and the schools within the area allotted him.

4. The Rat Destruction Officer makes a weekly visit to the area under each Malay Officer when he pays rewards for rat tails (at one

cent a tail) tendered by Ketuas, other cultivators and by school children. School masters are held responsible for keeping an account of the number of tails brought in by their scholars, although the Rat Destruction Officer makes weekly payments direct to the scholars. Thus the Rat Destruction Officer is engaged on five days every week visiting Malay Officers. One day, Friday, is reserved for office work, making up accounts and for any special work apart from the fixed routine.

C. Comparative Statement of Results.

Up to the middle of May the Campaign over the restricted area had yielded just over 100,000 rats in the following proportions (in round figures):—

Cultivators	...	17,000
Schools	...	28,500
P.W.D.	...	36,500
Total	...	82,000

To this total has to be added 24,000 rats reported by Ketuas to have been killed but for which no tails were seen nor any payment made, excepting that they were included in calculations made when selecting Ketuas for Special Rewards at the end of the last padi season.

2. It was decided that the acceptance of "Reported Killed" was unsatisfactory, so since the inauguration of the extended Campaign nothing is recorded unless tails are produced.

3. Between May 15th and August 28th, a period of 3½ months, over 195,000 rats have been killed. The proportions are:—

Cultivators	...	70,578
Schools	...	79,683
P.W.D.	...	45,394
Total	...	195,655

4. During the preparation of the fields for planting an attempt was made to encourage co-operative killing of rats by cultivators in the bendangs. The object aimed at was for each cultivator to leave a small area of uncut vegetation as a shelter in which rats would congregate. It was intended that adjacent cultivators should co-operate in cutting these isolated areas and in killing all rats that would have taken cover therein. The District Officer made at attempt to encourage rat destruction on these lines by fixing dates for rat drives in various localities. Notwithstanding these efforts it cannot be claimed that any very great simultaneous massacre of rats took place, although a certain amount of success was attained as shown by an increase in the weekly total of tails tendered. Not only so, but from enquiries made it would

appear that a large majority of the tails tendered throughout August were obtained from rats killed in the field by cultivators and not from trapping. This applies to tails tendered by school children as well as by cultivators: the children having obtained tails from rats killed on the lands of their relatives.

D. Brief Remarks on present position and indication of future lines of the work and aims.

To sum up, the present position is that trapping by Malays and rat hunts by Tamil coolies are the most successful methods of rat destruction in Krian.

2. Experience gained indicate that:—

(a) The use of poisoned baits has been effective only in certain localities and over short periods. No general success can be claimed for this method so far. The probable reasons are, (a) that rats quickly get suspicious of the baits and avoid them and (b) that the cultivators are not keen upon using them whilst rewards are being paid for tails as rats poisoned by one cultivator generally go to anothers land to die. Further experimental work with this method is advisable, but any undue pressure to force cultivators to use poisoned baits is unlikely to meet with success.

(b) Poison gas of any description for use in burrows is unlikely to be of any practical use in Krian. Burrows at no time of the year are sufficiently numerous to warrant spending the time required in searching for and treating them. A hunt by Tamil coolies will yield a greater return at less expenditure of time and labour.

(c) There are great potential possibilities from organised cooperative killing by the cultivators during "Menajak," but such organisation on a large scale will need much fostering before it can become a practical proposition.

3. Damage by rats to nurseries this year, as far as I can gather, has been nil. Only time will show if the same immunity will be enjoyed by padi plants and grain in the field as a result of the Campaign. If rat damage to the present crop should prove to be immaterial the money and labour spent on the Campaign will have been well worth while and a great incentive will have been provided to the cultivator to continued assiduity in rat destruction

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; and the Malay States Information Agency, 88, Cannon Street, E.C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV (1913-16) VIII & IX (1920-21) price $5.00 per volume.
Vol. V (1917) Nos. 1, 2, 3, 5 & 6 „ 250 per set.
„ VII (1919) „ 2—6 „ 4.50 „
(Vol. VI is out of print.)

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

Vol. X (1922) Price $5.00 per volume.
„ XI (1923) Price $5.00 per volume or 50 cents per single number.
„ XII (1924) „ „ „ „

Back numbers of Vols. I—X will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher.
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, 1910, 20 cts.
4. *Brachartona catoxantha, Hamps*, by H. C. Pratt, 1909.
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909.
6. Branch and Stem Disease of *Hevea Brasilienisis*, by W. J. Gallagher, 1909.
7. Coffea Robusta, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910.
9. Die-Back Fungus of Para Rubber and of Cacao, by K. Bancroft, 1911.
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher, 1910.
11. Coconut Cultivation, by L. C. Brown, 1911.
12. Padi Cultivation in Krian, by H. C. Pratt, 1911
13. A Root Disease of Para Rubber, *Fomes Semitostus*, by K. Bancroft, 1912, 20 cts.

C = Cancelled

THE

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STUDIES ON HEVEA LATEX.

IV.—THE PROTEINS.

W. N. C. BELGRAVE.

IN the third article of this series (1) an account was given of an attempt to apply the carbamate method to the proteins derived from latex, and the view was expressed that a better method for the separation of protein from rubber than that of insolation was needed. A description is given below of a method which may prove useful.

If fresh latex is largely diluted with water, alcohol (ethyl or methyl) may then be added without the occurrence of coagulation (2) The addition of either acid, salt, or strong base causes coagulation, and if a base is used, it is possible to remove the rubber and to leave a considerable amount of protein in the solution.

If the resulting rubber is washed and creped in the usual way Kjeldahl determinations show a remarkably low percentage of nitrogen—two samples giving A .09 per cent Nitrogen
B .06 per cent ,,

Sample A was made from a small quantity of latex and had not been very efficiently washed—in any case the difference of Nitrogen content from that of crepe prepared in the usual way—0.3—0 4 per cent—is striking.

Preparation of Protein.—11000 ccs of latex (N. 0.26 per cent) in five successive portions were diluted approximately five times with distilled water and equal volumes of 95 per cent alcohol added, a few small clots were removed, the whole bulked, and 12 ccs of 50 per cent. NaOH solution added with vigorous stirring. The resulting coagulum was squeezed in a hand-press, the serum rapidly filtered through a large Berkfield filter, and acetic acid added to pH4.4. The precipitate

(1) M. A. J. XIII No. 6 p. 154. 1925.

(2) c. f. de Vries' Rec. d. Trav. Chim d. Pays Bas XLII. iv ST III Nos. 7 and 8.

was filtered off, washed with very dilute acetic acid and with 50 per cent alcohol, and dried (1) over H_2SO_4, to a dark brown horny mass, which weighed 8.5 grams, and had a Kjeldahl nitrogen content of 11.6 per cent and ash .7 per cent. It will be noted that this amount of protein accounts for approximately one-third of the total nitrogen in Latex—i e. 60 per cent of the estimated total existing as protein (2) The remainder was doubtless absorbed by the coagulum and being in a soluble form, was washed away in the process of creping. The percentage of nitrogen (11.6) obtained without repurification is remarkable, and suggests that the method employed is suited for lthe purpose in view. The protein gave the zantho-proteic, Millon, biuret and Adamkiewicz reactions strongly and the Molisch reaction feebly; it did not reduce Fehling either directly or after prolonged acid hydrolysis. Gentle hydrolysis with dilute alkali failed to split off appreciable quantities of inorganic phosphorus.

These failures suggest that neither glyco (3) nor phospho-proteins are present in the 'protein' prepared by this method. The possibility or probability of splitting has, however, to be borne in mind and further investigations on this point are in progress.

Distribution of Nitrogen.—3 grams of protein were hydrolysed with HCl and treated as in Plimmer (4) for the separation of nitrogen into seven groups, the amyl alcohol-ether method being adopted for the breaking up of phosphotungstates.

Results were :—

Amide Nitrogen	...	7.7
Humin Nitrogen	...	0.5
Arginine	...	22.4
Cystine	...	0.7
Histidine	...	12.0
Lysine	...	0.2
Mon-amino Nitrogen	...	32.2
Non-amino Nitrogen	...	37.0
	Total ...	112.8

The large arginine and small lysine figures suggest that decomposition on boiling with soda was too far reaching. The small cystine figure agrees with an observation by the writer that organic sulphur remains in the solution after removal of protein. While the absolute figures differ widely from those indicated by the carbamate

(1) It may be of interest to note that this protein before drying was readily soluble in either dilute alkali or acid and from either solution was precipated about pH 5 by acid or alkali respectively.

(2) vide M. A. J. XIII p. 156.

(3) Whitby, Plantation Rubber p. 117.

(4) The Chemical Constitution of the Proteins, Pt. 1.

method (1) they agree to the extent that no one of the three large groups—diamino, mon-amino, or non-amino predominates over the others.

The amount of mon-amino nitrogen found is larger than might be expected, but requires confirmation. Troensegaard (2) has argued that the accepted methods of analysis give a false picture of the relations between chain and ring compounds in proteins, and it should be of interest to apply his methods to latex protein.

SUMMARY.

A simple and rapid method of separating 'protein' from latex is described.

It is pointed out that further work is necessary before it can definitely be said that the 'protein' as separated is actually in the form in which it occurs.

Figures for distribution of nitrogen into seven groups are given.

V.—THE POSSIBLE OCCURENCE OF A COALESCING ENZYME.

In the first paper of this series (1) evidence was brought forward to support the view that the postulate of Whitby, Barrowcliff and Campbell of a coagulating enzyme in latex could not be maintained, while it was held that the phenomenon met with could be explained by observed changes in the electrical charges of the caoutchouc globules; it was further postulated that the protein of latex was responsible for these changes.

The writer, at the time of preparation of this paper (3), was unaware that De Vries had come to similar conclusions as to the absence of a coagulating enzyme and the part played by electrical charges and had announced these conclusions at the meeting of the Koninklyke Academie Amsterdam in January 1923. (4) Again in the Receuil des Travaux Chimiques des Pays Bas (5) in July, 1923, De Vries described further work on the enzyme question which led to a reversal of his previous views, expressed in "Estate Rubber," on the comparative unimportance of enzymes in coagulation. Thanks are due to Dr. De Vries for bringing these two papers, previously unknown to the writer, to his attention.

It should be noted that De Vries does not specifically postulate a protein coating and is inclined to minimise the importance of protein in the observed phenomena, considering that resins are more probable emulsifiers and that in any case changes in the degree of solvation of the caoutcuouc itself are probably of great importance.

(1) M. A. J. XIII, No. 6, p. 154.
(2) Uber die Konstitution der Eiswiss verbindungen—Zeitsch f. ang: Chemie 38, p. 623—1925.
(3) Malayan Agricultural Journal Vol. XI No. 12.
(4) Proceedings XXVI, 9 & 10.
(5) XLII, iv S T Nos. 7/8.

Since that time a number of papers (1), (2), (3), (4), by De Vries have appeared dealing with the presence and properties of a coalescing enzyme in latex.

These papers must be read in the original, as the very considerable amount of work carried out by their author on the question of an enzyme defies brief abstraction.

It must suffice to state here that nearly all the work has been carried out on "B"-mixture i.e. diluted latex heated to 75°C or over. The properties of such latex, first noted by Barrowcliff, have been described many times—on addition of small amounts of acid (to pH 4.0) flocculation occurs, but not coagulation. If however, small quantities of unheated latex are added either before or after addition of acid, more or less rapid and irreversible coagulation ensues.

De Vries claims that coagulation of unheated latex must be regarded likewise as consisting of two stages viz. flocculation, brought about by changes of electrical charges, and coalescence which may be produced by a number of agencies among which is an enzyme, coalase, in latex. Under normal conditions the second stage follows so rapidly on the first that it is indistinguishable from it.

This enzyme is entirely absorbed by the coagulum, but may be washed out of an alcohol—coagulum with water and precipitated with an excess of alcohol.

Excess of acid destroys the enzyme; latex to which sufficient acid has been added to bring it into the "gap' has no coalescing power on "B" mixture, though itself capable of coagulation when the acidity is reduced; latex preserved with ammonia similarly loses coalescing power.

Enzyme poisons such as H_2S or HCN have little or no effect on coalescence of acid 'B' mixture by latex.

Papain which is effective in coagulating even alkaline latex, also coagulates 'B' mixture.

Many other agencies, such as excess of strong acid, alcohol, B-Napthol, and drying are found to be effective in bringing about coalescence.

The enzyme coalase is not able to de-emulsify latex, and can only act when de-emulsification has been brought about, the coalescing action is rather slow and by no means indipensable. It is considered, however, that the enzyme is effective in ordinary estate practice.

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(1) Arch. v. d Rubb. Cult. VII p. 168.
(2) „ „ „ „ „ VIII p. 219.
(3) „ „ „ „ „ VIII p. 233.
(4) „ „ „ „ „ VIII p. 726.

De Vries' conclusions have been criticized by Groenwege (1) who claims that the behaviour of "B" mixture can be explained as the conversion of a hydrophile to a hydrophobe colloid, and the irreversible denaturing of the proteins of latex, rendering low H—ion concentrations unavailing for coagulation, until unheated latex is added when a fresh lining layer is formed.

Groenwege also instances the occurence of coalescence in the presence of cyanide as an argument against an enzyme.

De Vries has replied to these criticisms and maintains his original views.

EXPERIMENTAL WORK.

Almost the whole of De Vries' results have been confirmed by the writer except that fresh latex has been found to have a lower efficiency than that found by De Vries. Whereas that author finds coalescence overnight with 1 pt. latex to 256,000 parts of B mixture (1 : 9), the writer finds the limit at 1 : 20,000—when the fresh latex is added before the acid, and 1/1000 when added after; this difference is however immaterial to the argument for or against an enzyme. It is admitted that there is some substance in latex, sensitive to heat, strong acids and alkaline, which can bring about coalescence in acidified B mixture. The problem is—is this substance an enzyme which functions in unheated latex or are the conditions of experiment so different from normal that no such conclusion can be drawn?

In order to prevent misunderstanding, it may be as well to state that to the writer the word 'enzyme' has a functional significance, and should be reserved for a thermo-labile catalyst which plays a part in some naturally occurring portion of the economy of the organism. The fact that some reaction, abnormal to an organism is assisted or conditioned by a thermo-labile substance present in that organism, does not, to the writer, suffice, in itself, to justify the deduction that an 'enzyme' exists for a similar, but not necessarily identical reaction.

In the article on coagulation it was suggested that the explanation of the non-coagulation of 'B' mixture was to be found in a protein heat change which results in the formation of an actual 'skin' around the globules—practically the same suggestion as that of Groenwege.

The writer does not consider that De Vries has proved his case for an enzyme because the case for an extension of argument from heated to unheated latex remains unsupported, and is in fact contradicted by the observation that 'gap' latex, although itself retaining the power of coagulation, cannot bring about the coalescence in acidified 'B' mixture; as De Vries himself points out, this shows that other changes have occurred, most probably in the proteins. Yet in developing the enzyme argument this admitted heat change is completely neglected. Similar behaviour is shown by 'B' mixture which has been rendered alkaline before heating (2), on neutralisation and

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(1) Arch. v. d. R. C. 8 No. 9 p. 626.

(2) Malayan Agricultural Journal Vol: XIX No. 12.

acidification perfect coagulation follows although the heated fluid has no coalescing power on ordinary 'B' mixture. Control experiments with equivalent quantities of salt added to 'B' mixture before or after heating do not show coalescence. Both these cases suggest that if no heat change occurs, or if heat change is prevented, (or more likely carried further than usual) then coagulation can proceed in absence of 'coalase'. If this is accepted it is difficult to see the necessity for assigning an active part to 'coalase' in the coagulation of unheated latex.

An endeavour was made to throw further light on the nature of the 'heat' change. As proteins appear to be the most likely object of change it was decided to try the action of proteolytic enzymes other than papain, the action of which is known to be complicated by a coagulative action. It is commonly said that pepsin has no action on Hevea latex; this statement is incorrect and is due to disregard of the H—ion concentration of the medium. If pepsin be added to the latex in the 'gap' (e g. 2 ccs of 1% pepsin to 50 ccs dilute (1 : 1 or 1 : 9) latex, acidified to pH3) coagulation follows. The same result is obtained with "B" mixture. Control experiments with boiled pepsin show no coagulation.

Trypsin.—If similar experiments are made with trypsin on slightly alkaline (pH-8.5) latex, coagulation does not follow—if, however, such latex after neutralisation, or slight acidification to pH 6.0 be heated as for 'B' mixture, and acidified, coagulation now proceeds rapidly and perfectly. Control experiments with boiled, slightly alkaline trypsin give negative results.

It is easy to show by Kjeldahl determinations on the washed rubber that papain, pepsin and trypsin all three considerably reduce the quantity of insoluble protein—and it seems fair to regard their mode of action in promoting coalescence as prevention or removal of a 'skin' of denatured protein.

It is noteworthy that trypsin added to pH 8.5 *after* heating does not act so as to permit coalescence on acidification: this should be considered in connection with the fact that trypsin is unable to act on many insoluble proteins.

It is interesting to note that latex treated with trypsin, like that heated with soda, shares with latex preserved with ammonia the property of coagulating very rapidly on acidification. De Vries (1), has drawn attention to this, as far as ammonia latex is concerned, and ascribes it to protein hydrolysis; surely an argument in favour of protein as an emulsifier.

Although it cannot be concluded that De Vries is justified in arguing from 'B' mixture to latex, it is necessary to endeavour to explain the phenomenon described. If it is taken as correct that denatured protein is responsible for the absence of coalescence, a proteolytic enzyme at once suggests itself as an obvious agent in the

(1) Arch. f.d. Rubb. Cult. VII. p.168.

production of coalescence in 'B' mixture. It is clear that such an enzyme if it exists may be expected to act only at pH 4.4-5.4, and that the task of demonstration will be complicated by coagulation and absorption.

The usual methods for identification of a proteolytic enzyme—action on fibrin, gelatin, albumen, lecithovitellin, peptone, analysis of serum after rapid and slow coagulation, dialysis and tests with ninhydrin, all failed to reveal a proteolytic enzyme. Other possibilities must therefore be considered. De Vries has pointed out that alcohol, quinin, B napthol etc. are effective; the writer has found that oleic acid or oleates are highly effective (1 part of 1% sod. oleate to 1000 of acidified 'B' mixture 1:9) producing coalescence overnight. This at once suggested an analogy with hæmolysis, but it was found that neither saponin nor curare was effective. As a result of a number of experiments it was found that the coalescing action of various organic substances on acidified "B" mixture depended on molecular weight and constitution e.g. Me-OH < Et-OH < Amyl OH = Phenol. (1)

Acetic acid < iso butyric = iso valerianic = benzoic = salicylic < stearic < oleic.

Benzaldehyde and nitrotoluoul were about as effective as phenol.

Benzol and toluol were less effective than their derivatives.

Aniline, pyridine and morphine hydrochlorides were ineffective.

Lecithin and resinates prepared both from the commercial products and from latex were moderately effective.

Castor and rubber seed oils were effective in proportion to their impurities (fatty acids).

These results suggest surface action according to Langmuir—and not mere solvent action and consequent swelling of the caoutchouc.

If this is granted, it is possible to conceive of the presence in latex of a thermo-labile, easily destroyed substance which accidently coalesces 'B' mixture and may also be expected to be a potent emulsifier for caoutchouc. Such a substance in its nature cannot be easy to identify—but as a guess we may assume a lecitho-protein, or possibly a lecitho-sugar protein complex—very rapidly broken up, and once broken up or thrown out of its natural state, irreversible

(1) The general method of experiment was to make 1-5% solutions in water or methyl alcohol, to dilute or emulsify the appropriate quantity with 10 ccs water and mix rapidly with 40 ccs of 1·8 'B' mixture. The preliminary mixing with water is essential in order to prevent instantaneous clotting at the point of addition, with consequent removal of some of the added substance.

and inactive. This irreversibility of lipin complexes (1) is well known.

De Vries (2) has argued in favour of resins rather than proteins as emulsifiers because :—

(a) Resin is a more likely emulsifier on Langmuir's theory.

(b) The quantity of protein in latex is proportional to the latex and not to the caoutchouc.

(c) A large part of the nitrogenous bodies may be removed by creaming, dialysis etc, without change of the coagulation phenomena

The second and third arguments appear to be unsound as they ignore the facts that Kjeldahl determinations give no indication of the proteins as such, that methods of 'resin' determination are useless as an index of specific undecomposed substances in latex, and finally that if the proteins are interfered with by tryspin, standing with ammonia etc, the coagulation phenomena are markably altered.

The writer has previously (3) endeavoured to show that 'resins' i.e. the extracted medley of substances so called, cannot be responsible for the behaviour of latex, as their precipitation points do not coincide with those of latex.

The opposing points of view—viz, proteins v. 'resins' as emulsified appear to be admirably reconciled by the conception set forth above, of a lipin protein complex -in which the fatty acids of the lipin would attach themselves to the caoutchouc while the protein would be attracted to the water of the serum.

On theoretical grounds it is quite possib'e that much of the so-called 'resin' is really various break-down products of the lecithin of latex. Whitby has shown fatty acids to be an important part of rubber 'resins' and such acids are also part of the lecithin molecule. If this view should be shown to be correct, the surprisingly different acid contents of rubber (4) prepared by different methods would be explained.

Work has been initiated and will be continued, to test the hypothesis of the occurence of a lipin-protein complex.

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(1) Moran. Effect of low temperatures on hens eggs' Proc. Roy. Soc B-98, page 442.

(2) Arch. f.d. Rubb. Cult. VIII No. 5.

(3) Malayan Agricultural Journal Vol. XI, No. 12 page 365.

(4) Whitby, and Winn. The Acidity of Raw Rubber. J.S.C.I. XLII, No. 32, page 336T. 1923.

Summary.

Reasons are given for disagreeing with the conclusion that a coalescing enzyme exists in latex.

The action of proteolytic enzymes on latex is described.

The influence of some organic substances on coalescence of 'B' mixture is described.

A suggestion is made of the presence in latex of a lipin-protein complex which may function as an emulsifier and also as a coalescing agent on acidified 'B' mixture.

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NOTE ON BANANA FIBRE.

R. O. Bishop.

An attempt has been made to collect some data on the fibre which occurs in the stem of the banana plant. In the Malay Peninsula there are three species of banana described by Ridley as occurring naturally, and in addition there are a number of imported varieties which flourish and are cultivated for their fruit by native small-holders As far as the writer is aware the banana plant is not cultivated in this country for its fibre although a few inferior specimens of banana stem strippings have been seen at local Agricultural shows.

Of the wild bananas there are only two of which the extent of their distribution appears to justify further attention at the present time. These two species are described by Ridley as follows:—

Musa malaccensis Ridl.—Stems ten feet tall or more, six inches through, leaves eight feet long, barred or splashed brown when young. The fruit is subcylindric, four inches long, yellow, and having a sweet scanty pulp. Occurs commonly in hill forests and is often found in immense quantities in the jungle.

Musa violascens Ridl.—Stems slender, eight to ten feet long. Leaves ten inches across, glaucus beneath. Spike erect, acute. The fruit is angled, one inch through, three inches long and green. Common, growing with *Musa malaccensis* in great abundance.

Fibre from Musa malaccensis, Ridl.

The fibre was prepared by hand stripping from plants growing at Kuala Kangsar. Nineteen fresh plant stems were treated, the yield of sun-dried fibre was 2 75 lbs.

Description	Colour	Grey to white.
	Cleaning	Good.
	Texture	Coarse, somewhat uneven some strips.
	Length	Two feet average.

Micro-Chemical Examination.—A sample of the dry fibre was digested with soda solution, washed and treated with chlorine at 0°C. The bleached material was washed with aqueous sodium sulphite and suspended in water. If the digestion and chlorine treatment are efficient the fibrous filaments when shaken with water will separate into individual fibres, samples can then be removed with ease and examined microscopically. Forty separate counts were made and the average dimensions of the ultimate fibres were :—

Mean length .....3.58 m.m. Max....5.66 m.m. Min....0.9 m.m.
Mean Diameter......27 x 1/1000 m.m.

The form was regular, cylindrical with sharply pointed ends, under a magnification of 165 the central channel is distinct as for Manila Hemp fibres.

With Zinc Chloride and Iodine the fibre was stained deep blue, after a transient claret colouration in some parts of the slide.

With Iodine the colouration was brown.

With Sulphuric acid and Glycerine there was no colouration.

Fibre from Musa violascens, Ridl.

Fibre was prepared by hand stripping from plants growing at Kuala Kangsar. Twelve stems yielded 2 lbs of sun dry fibre.

Description	Colour............Brown.
	Cleaning....... ..Medium to poor.
	Texture...........Coarse and strippy.
	Length............Five and a half feet average.

Micro-Chemical Examination.—A sample was prepared for examination according to the method previously described. Fifty separate counts were made and the average dimensions of the ultimate fibres were found to be:—

Mean Length......4.40 m.m. Max...6.8 m.m. Min...2.5 m.m.
Mean Diameter...25 x 1/1000 m.m.

The form was regular, cylindrical with sharply pointed ends. Under the higher magnification the central channel was well defined.

With Zinc chloride and Iodine the fibre was stained a deep blue.

With Iodine the colouration was brown.

With Sulphuric acid and Glycerine there was no colouration.

Fibre from the Stems of Cultivated Banana Plants.

For the purposes of comparison a parcel of fibre was prepared from a mixed collection of Banana Plants under cultivation on the Government Experimental Plantation, Serdang. Strictly speaking the plants were not cultivated, in as much that the stems treated were those of plants which had been left over at the time of planting a series of observation areas.

The varieties included in the test are those belonging to the *sapientum* group, but no attempt has been made to differentiate between individuals. The age of the plants at the time of cutting was approximately fourteen months.

The fibre was prepared by stripping the stems immediately after cutting. The stripping knife used was similar to that employed in the Philippine Islands by the natives who prepare Manila Hemp.*

Yield.—The cultivated banana plant as it is cut down contains a considerable proportion of total weight which cannot be regarded as raw material for producing fibre. The crown must be removed and discarded as well as a few inches at the base of the stem. In the present instance the plants cut at the Government Plantation were trimmed before being sent to the Agricultural Department for treatment. The stems as received for stripping still contained two or more outer sheaths which had to be discarded. The proportion of wet material finally obtained in a form suitable for stripping can be gathered from the following figures.

TABLE I.

Yield of Dry Fibre from fresh Cultivated Banana Stems.

Plant number.	Total height.	Total Weight.	Weight of Stem.	Length of Stem.	Weight of stem suitable for stripping.	Length of dry fibre produced.	Weight of dry fibre.
—	feet.	lbs.	lbs.	feet.	lbs.	feet.	ozs.
1	13.7	50	42.0	7.5	21	6.1	1.3
2	13.8	70	55.5	7.7	46	5.5	2.0
3	14.5	56	14.0	6.5	35	4.5	1.0
4	12.7	45	36.0	6.0	32	4.5	1.0
5	20.0	97	66.0	8.0	[illegible]1	5.0	1.5
6	19.2	62	51.0	8.7	39	4.7	1.4
7	17.7	103	76.0	7.5	61	5.2	2.4
8	18.2	83	58.0	8.7	48	5.5	2.0
9	21.2	112	79.5	9.0	61	7.0	3.0
10	20.2	85	66.0	9.5	56	6.0	1.5
11	18.7	86	67.0	9.5	54	5.5	2.0
12	17.0	89	74.0	7.8	56	5.5	4.0

Total weight of Plant cut...	938 lbs.
Weight of stem suitable for stripping.........	563 ,,
Weight of Dry fibre obtained..................	23.1 ozs.

From a further series of twelve plants grown in the same place and treated in the same manner as those above, but at a slightly later date, the following record was made :—

Total weight of Plant cut...	670 lbs.
Weight of stem suitable for stripping.........	409 ,,
Weight of dry fibre obtained...	13.0 ozs.

*See Malayan Agricultural Journal Vol: 13 No. 5.

Description.—The fibre obtained from the cultivated banana stems was characterised as follows:—

Colour..................	Light biscuit to grey.
Cleaning................	Good to medium.
Texture.................	Fine to soft, no strips, some lustre.
Length..................	Five and a half feet average.

In appearance the banana fibre as prepared at the Department of Agriculture was very similar to the good grades of "Partially-Cleaned" Manila Hemp; in particular, to the fibre classified according to the standards adopted by the Philippine Islands Official Code as "Manila Hemp Strips."* According to an impartial judgment the banana fibre was slightly inferior in colour to "Good Fair" Manila Hemp though somewhat finer. It was shorter but its appearance was superior to that of "Fair No. 1 Manila Hemp."

Micro-Chemical Examination.—A sample was prepared for examination according to the described method and fifty counts of ultimate fibres gave the following results. Figures for an exactly similar examination of "Good Fair" Manila Hemp are given side by side for comparison

Characteristics of Ultimate Fibres.	Cultivated Banana Fibre.	"Good Fair" Manila Hemp.
Ultimate fibre Mean Length ...	4.46 mm.	4.19 mm.
Max: Length ...	6.30 mm.	7.20 mm.
Minimum Length ...	2.34 mm.	2.70 mm.
Mean Diameter ...	22 × 1/1000 mm.	19 × 1/1000 mm.
Colour with Zinc chloride & Iodine...	Transient claret passing to deep blue.	Deep blue.
Colour with Sulphuric acid & Glycerine.	nil.	nil.
Colour with Iodine...	Brown.	Brown.

* Philippine Agricultural Review, Vol. 16 No. 2 Fibre Number.

Comparative Strength of Banana Fibre and Manila Hemp.

In order to establish a comparison between them, samples of the fibre from the two varieties of wild banana and the cultivated or fruiting varieties were tested for tensile strength on a Schopper Machine. Samples of Government graded standard Manila Hemp were tested at the same time, The results are given in Table II.

Table II.

	Sample.	Number of Tests.	Mean weight of 1 metre of sample. grms.	Mean Load at Break. Kilos.	Mean Tensile Strength Kgs. per unit gram-metre.
1	*Musa malaccensis* -	10	0.5794	14.5	28.1
2	do -	10	0.4484	10.5	23.5
3	*Musa violascens* -	10	0.5944	12.8	21.5
4	do -	10	0.8055	18.5	23.0
5	Banana Fibre -	10	0.2716	9.0	33.2
6	do -	10	0.2947	9.6	32.6
7	Manila Hemp "Good Current" -	10	0.6270	27.2	42.3
8	Manila Hemp "Good Fair" -	5	0.6099	19.5	32.2

The determinations were carried out in accordance with the procedure adopted by the U. S. A. Bureau of Standards. In each test a sample consisted of 30 strands of fibre.

The breaking load was determined at both ends and in the middle of each sample, the figure recorded was the mean of three breaks. The length of fibre between the jaws of the machine at the commencement of the application of the load was twenty centimetres. The humidity of the atmosphere at the time of conducting the tests was such that the moisture content of the fibre was approximately twelve per cent of the total weight of the fibre.

Chemical Examination.—An examination of samples of the fibres was carried out according to the procedure standardised by Cross and Bevan. The results obtained are given in Table III.

TABLE III.

...	Musa malaccensis	Musa violascens	Cultivated Banana	Manila Hemp "Good Fair"
	per cent	per cent	per cent	per cent
Moisture -	12.29	12.07	10.4	11.45
The following results are calculated on the moisture-free sample.				
Ash -	2.47	1.47	2.6	1.69
Water-washing loss -	1.91	1.8	6.9	2.59
Acid-washing loss -	3.25	3.03	9.5	3.16
Hydrolysis "A" loss -	18.74	17.7	21.0	15.33
Hydrolysis "B" loss -	25.62	25.0	29.3	21.83
Cellulose -	3[illegible].62	30.7	34.2	71.08

Observations.—The data which has been collected, although somewhat limited, is an indication of the superiority of fibre from cultivated varieties of banana over that obtained from the native wild varieties. Although the cultivated banana yields a relatively small quantity of fibre, yet in quality it resembles the medium grades of "partially-cleaned" Manila Hemp. From the work so far carried out it appears that fibre from cultivated banana stems would be difficult to identify if used as an adulterant of certain grades of Standard Manila Hemp.

The results indicate that the work could be profitably extended to include an examination of the fibre from particular varieties of cultivated banana plants.

Received for publication 14th November 1925.

REPORT ON THE CHEMICAL EXAMINATION OF FIBRE FROM THE BARK OF TERAP, TUTOR AND BARU.

R. O. Bishop.

IT appears that the barks of the trees Terap, Tutor, and Baru are recognised by the natives of the Malayan Peninsula as sources of serviceable fibrous material and that the beaten bark of the Terap finds use as a cloth among some of the Sakai. At one time these barks were the material most largely used in the construction of the walls of kampong dwellings and the Kulit Terap still finds use among the fishing people for the manufacture of cordage and netting.

A sample of Tutor bark fibre was first examined in this laboratory in 1921, and was found to be a fibrous material of high strength and suitable for the manufacture of paper of a superior quality. Samples of Terap bark were first examined during the present year and the results were sufficiently promising to indicate the desirability of carrying out a more extended examination on further samples. For this purpose the Forest Research Officer, F.M.S. and S.S. supplied larger parcels of the air-dried bark and the present report is a record of the results obtained on the examination of those samples. It is believed that the results of a similar examination have not previously been recorded.

Description of samples.—The following notes on the barks have been furnished by the Forest Research Officer, F.M.S. and S.S.

Terap.—*Artocarpus Kunstleri.* King. A rather common tree in belukar (secondary jungle). Sometimes as much as 100 feet in height and two feet or more in diameter, but usually smaller. The leaves are coarse and roughly hairy and the bark contains a considerable amount of a white, sticky sap. The wood is of inferior quality. The tree is also found in other parts of the Malayan region.

Tutor.—*Hibiscus macrophyllus.* Roxb. A small or medium sized tree, which is of scattered occurence in belukar. Trees 10-60 feet in height and as much as one foot in diameter are found. The tree is also found in India and Java. The leaves are smooth and green above and whitish tomentose beneath. The large flowers are yellow with a purple centre and fade to a purplish colour.

Baru.—*Hibiscus floccosus* Mast. Known also by the names,—Kangsar, Kapas-Kapas, Petutu, Unchang, Bebaru. A small to medium-sized tree in belukar. Trees up to 60 or 80 feet in height are sometimes found, but they are usually much smaller. The leaves are large and coarse, with hairs. The flowers are large and bright yellow; known only from the Malay Peninsula.

Chemical Examination.—The air-dry material was brushed by hand to remove any adherent soil or mould and was then sampled by punching 2 inch squares from the ends and centres of each strip of

bark. It is important to note that the material freshly stripped from the tree is very liable to rot, unless thoroughly air-dried and in the present case some strips of bark from the centre of the parcel had to be rejected on account of their obvious deterioration. From each 100 lbs. of bark ten pounds of 2 inch squares were bulked and two separate lots of 100 grams were taken for analysis.

The chemical examination was carried out according to the standard procedure adopted in this laboratory from the methods described by Cross and Bevan*. The results obtained are recorded in table I.

TABLE I.

——	Terap.		Tutor.		Baru.	
	Per cent		Per cent.		Per cent.	
Moisture -	13.51	10.0	13.95	12.56	12.70	12.73
Results calculated on the "Moisture-Free" Sample						
Ash -	1.15	3.61	4.60	1.23	1.32	1.34
Water Purification Loss -	6.82	7.00	8.51	5.27	1.35	4.35
Acid Purification Loss -	9.09	9.35	7.03	5.92	6.81	7.08
Hydrolysis A Loss -	26.43	18.62	15.94	10.72	18.58	13.30
Hydrolysis B Loss -	31.12	31.10	30.01	21.20	26.68	23.1
Cellulose Content -	63.7	61.5	51.20	71.0	63.00	69.5

In order to establish the significance of these figures a series of results which have been obtained by similar methods on other fibrous materials are recorded in Table II.

TABLE II.

——	Loss on Hydrolysis B.	Cellulose.
Fibre Moisture Free.	per cent.	per cent.
Prime Manila Hemp, pecto-cellulose -	17.6	76.6
Hemp (Cannabis sativa), pecto-cellulose -	14.3	77.7
Sisal Hemp (Agave sisalana), pecto-cellulose	14.0	78.2
Baobab (Audansonia digitata, ligno-cellulose	22.6	58.8
Jute, (Corchoru spp), ligno-cellulose -	25.7	63.76

* Cross and Bevan. "A Text Book of Paper Making". Page 101.

Microscopic Characteristics.—The samples were subjected to a digestion with soda and the pulp obtained was beaten until the bast filaments were separated into individual fibres. These fibres were examined for length, diameter, and micro-chemical reactions. Fifty fibres were measured from each sample, the average of the results, together with those from some other bast fibres are recorded in Table III.

TABLE III.

Fibre.	Length of Ultimate Fibre in Millimetres.			Diameter of Ultimate Fibre in 1/1000 Millimetre.	
	Average	Max.	Min.	Average	Max.
Terap -	18.0	27	9	33.3	43.7
Tutor -	3.3	4.5	1.8	25.7	28.5
Baru -	3.2	3.6	2.5	25.7	31.4
*Hemp -	22.0	—	—	22.0	—
*Jute -	2.5	—	—	22.0	—
Roselle -	3.1	1.8	0.8	28.5	—

The characteristics of the ultimate fibres of Tutor and Baru were found to be very similar, smooth round fibres with well defined pointed extremities, regular in form and, in the case of Baru, particularly regular in length. When stained with Iodine and Sulphuric Acid in Glycerine the fibres gave identical yellow—grey colourations. With Zinc Chloride and Iodine the colouration was blue, with only a transitory violet.

The ultimate fibres from the Terap bast are irregular though having a high average length. The fibre extremities are sharp in many instances but blunt round ends have been observed; this may be connected with the peculiar nodal swellings which occur regularly at intervals throughout the length of some of the fibres. Fibrillae are attached at these nodes.

When stained with Iodine and Sulphuric Acid in Glycerine the Terap fibres are coloured yellow. With Zinc Chloride and Iodine the colouration is first a wine red which, with the increased percolation of the stain, changes to deep blue.

Comparative Strength of the Fibres.—With the facilities available it was not possible to carry out any work which would serve to determine the utility of the fibrous materials for rope making. It

*Cross and Bevan. Ibid.

was however possible to subject sufficiently large samples of the three barks to a uniform treatment with soda in a rotating spherical digestor and beat out a pulp which was suitable for making hand-made "boards." The "boards" were pressed, dried and calendered and cut into strips for tests on a paper testing machine.

Particulars of the treatment, which was adhered to for the three different materials, were as follows :—

Quantity of Air-dry Bark treated ... 50 lbs.

(*a*) Digested with water to a steam pressure of 65 lbs per sq. inch for 60 minutes, then drained and washed with cold water.

(*b*) Digested with soda solution (10 lbs in 10 gallons water) at a pressure of 65 lbs. per sq inch for 6 hours.

(*c*) The pulp was then washed with water and beaten for 3 hours.

(*d*) The beaten pulp was diluted with water and afterwards made into boards on a hand mould. The boards were dried in the open air and calendered between steam heated rolls. The average dimensions of a board were :- Length 20 inches, width 10 inches, weight $\frac{1}{2}$ lb.

A test strip $\frac{5}{8}''$ wide by $12''$ long was cut from each board. Table IV gives the results of breaking thirty strips from each material on a Schopper paper testing machine. The distance between the jaws of the machine at the beginning of each test was adjusted at $1''$.

TABLE IV.

Material.	Mean Thickness of Test Strip	Mean Load at Break	Mean Tensile Strength	Coeff : of Deviation from Mean
	inches.	lbs.	lbs. per sq. inch.	per cent.
Terap -	0.0212	9.46	725.6	20.27
Tutor -	0.0295	11.19	607.6	18.71
Baru -	0.0393	12.33	520.6	15.25

Separate portions of the beaten pulp were used in small trials for bleaching. The bleached pulp was not examined quantitatively. The colour of the bleached pulp, relating to the consumption of chlorine, was good and it should be possible to produce a satisfactorily bleached paper from one of the three barks.

Conclusions.—The Tutor and Baru barks are almost identical in chemical and microscopic characteristics and appear to be suitable for making a paper, of good quality.

The Terap bark, although chemically similar to the Tutor and Baru, has a much longer ultimate fibre. This is comparable with Hemp and it appears from the results of this examination that the Terap bast after suitable treatment might be utilised for some of the same purposes as Hemp. The promising characteristics of this fibre indicate the desirability of investigating yields and the possibilities of obtaining supplies from saplings and young trees of known ages.

Received for publication 12th November 1925.

YELLOW PHOSPHORUS AS A POISON FOR THE DESTRUCTION OF WILD PIG.

B. J. EATON.

ACCORDING to the Administration Report for the State of British North Borneo 1924 (pages 9, 27 & 29) a preparation manufactured in Sourabaya, Java and imported into Sandakan at a cost of $5.50 C.I.F. per 10 lb. tin has been used with considerable success for the dessruction of wild pigs, which are a serious pest in British North Borneo.

A sample of this preparation has been forwarded to the Department of Agriculture as the active ingredient has been found to consist of yellow phosphorus.

It is well known that yellow phosphorus is a virulent poison to mammals and is used in pastes to destroy various animals. At least one proprietary rat poison contains yellow phosphorus as the active ingredient.

When dissolved in oils or fats, the phosphorus is more effective since oils or fats assist its absorption or ingestion. Preparation of a phosphorus bait:—A satisfactory paste can be prepared according to the following formula and at the cost shewn.

		$	cts.
Phosphorus (2 ozs)	...	0	30
Flour (40 ozs = 2 catties)	...	0	26
Sugar (20 ozs = 1 catty)	...	0	10
Coconut oil (40 ozs = 2 catties)	...	0	56
Total cost	...	1.	22

The total cost per 10 lb tin, including fuel and labour required for preparation should not exceed $1.50.

The mixture is prepared as follows :—

The phosphorus is cut into small pieces, not larger than the size of rice grains and mixed with 50 ozs ($2\frac{1}{2}$ pints) of boiling water. The flour (tapioca starch can be used in lieu of flour) is then added and the mixture well stirred and allowed to cool. When nearly cold, the oil or fat (coconut oil is probably the cheapest and most suitable fat for local use) and sugar are added and the mixture is well stirred to incorporate or emulsify the fat with the remainder of the mixture. The quantities given in the formula above, together with the water, produce about 10 lbs of the preparation.

The paste may be spread for use on any suitable medium, such as bread, coconut meat, etc. or made into balls by adding more flour, starch, coconut or other oil seed cake or meal.

Warning :—Yellow phosphorus is a dangerous chemical and requires careful handling under good supervision. The inhalation of the fumes, when phosphorous is exposed to the air, and the handling of the chemical may cause poisoning if care is not taken.

Secondly the chemical is exceedingly inflammable when exposed to air and should always be kept under water and preferably cut into small pieces under water.

If the mixture is prepared locally, it should be made preferably in an open shed under the supervision of some person who is acquainted with the dangerous and poisonous character of the chemical and who has been trained in the handling of it.

Received for publication, 30th November 1925.

NOTE ON *SPHAERONEMA FIMBRIATUM.*

A. SHARPLES.

THE writer's attention has been drawn to a short note (1) in Phytopathology, Vol. 13, 1923 page 56 respecting the true systematic position of this fungus, the cause of "Mouldy Rot Disease of the Tapped Surface" of *Hevea brasiliensis* (2). For the benefit of other disease workers in Malaya the note is published below :—

"The fungus known as *S. fimbriatum* has been described as having three forms of asexual spores, two of which are borne on free conidiophores and a third in a long-beaked pycnidium. Examination of embedded and sectioned material has shown that the supposed pycnospores are ascospores which are apparently liberated within the perithecium by the early disintegration of the ascus. The ascospores are produced by free cell formation within the ascus, each ascus at maturity containing typically, eight spores having a single well defined nucleus. The perithecia originate in a hyphal knot, arising, at least, in some cases, from the intertwining of branches from two distinct hyphal strands. The taxonomic characters place the fungus in the genus *Ceratostomella* and the specific name *C. fimbriata* com, nov, is therefore proposed for it

(1) Elliot, A. John—The Ascigerous stage of the Sweet Potato Black-Rot fungus.

(2) South, F. W. & Sharples, A.—"Mouldy Rot, Bulletin No. 37, Department of Agriculture, S.S & F M.S.

Received for publication, 30th November 1925.

NOTE ON EPIPHYTIC GROWTHS ON RUBBER TREES.

A. SHARPLES.

IN the latest issue, October 1925, of the Bulletin issued by the Rubber Growers' Association, attention is drawn to the above subject by Mr. H Pinching, who mentions a statement made in a lecture given by the writer, under the auspices of the Incorporated Society of Planters at Kuala Lumpur, to the effect that attempts to remove epiphytic growths from rubber trees in *Ceylon* had led to a big increase in number of cases of Patch Canker.

The present note is written in order to prevent misunderstanding amongst Ceylon contemporaries. The statement made was with reference to S. India and taken from a report by R. D. Anstead, and the insertion of Ceylon for S. India is probably a mistake on the part of Mr. Pinching or the editor of the Bulletin. The lecture is printed in full in "The Planter," Vol. VI. No. 3 Oct./1925.

Received for publication 30th November 1925.

REVIEW.

The Plantation Rubber Industry in the Middle East.

DAVID M. FIGART.

Special Agent, Crude Rubber Survey Dept. of Commerce U.S.A.

THIS is the second of a series of three books on crude rubber, the first of which "Marketing of Plantation Rubber" was published early in 1921, and the third of which has yet to be published. The present volume deals with the economics of the production of rubber in the Middle East; which—as is pointed out in the Preface—produces 96% of the rubber of the world. Bearing in mind that the area of rubber in Malaya is half the total for the Middle East, the problems touched upon and the comparisons drawn between one country and another must be of moment to all in Malaya whose interests are centred in this industry.

The records in this work take the reader up to February 1924, while subsequent information of a statistical nature is embodied in the Introduction.

The book is less the opinions or conclusion of the Author than a compilation of the official and non-official records on rubber, together with a review of the problems bearing on the subjects, and stating in many cases the opinions of collections of men in rubber producing countries. The criticism may be advanced that nowhere in the book does the Author make definite deductions, but leaves the reader with a mass of facts and figures—most valuable themselves—from which he may draw his own conclusions. Were it not for the fact that on page V one is promised such conclusions, the reader would be content to place the volume on his reference shelf.

Mr. Figart is to be congratulated on the ability with which he has marshalled his facts and figures, and the excellent arrangement of the sections, which enables the reader to refer a problem as it applies to a particular country, or to the industry as a whole.

The different points of view in which the industry is reviewed are:—financial aspects, general problems, reports on individual countries, native plantation rubber industry in Sumatra, statistics, and a summary: in addition to which there are 26 pages of "Production illustrated", which might with advantage have been omitted from a work of this description.

The sections on the financial aspects of the industry; reports on individual countries; native rubber; and statistics embrace the valuable records. Mr. Figart's book is perhaps the most noteworthy production on the subject that has appeared for some time, and will be

found of great value to the large public interested—from one standpoint or another—in rubber; and for those who wish to investigate any question more fully than is possible in a work of this size, the excellent bibliography, which is included, will prove of great use.

But where a book of 300 pages is made to cover as much ground as does the present volume, there are sections which are bound to call for criticism. The section dealing with "Diseases and Pests" calls for comment in that the information contained therein is so scanty as to be almost misleading. However, Malayan planters are well-grounded in their knowledge of "Diseases" of Hevea, and the mistakes in the section above-mentioned are not likely to escape their notice. Even a specialist on "Diseases" of *Hevea brasiliensis* could not convey information of much value in three or four pages, which is the space allotted to a resumé of the disease problem in all the Rubber Growing countries of the Middle East. The chief criticism to be made is that the present volume would have gained in value by the omission of such short references to complicated technical problems; many of the problems connected with all branches of the industry are still debatable and opinions vary considerably from year to year as more information is gained. It is obvious, that under such conditions, great care is necessary when condensing the views of authorities on technical problems, and in this particular the sections dealing with technical problems are not up to the standard of the rest of the volume.

D. H. G.

Received for publication, 30th November 1925.

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Abstract of Meteorological Readings in the various Districts of Malaya for the 2nd Quarter of 1925.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds	Total Rainfall.	Greatest Rainfall during 24 hours.
April—													
Kelantan, Kota Bahru	...	146.	83	91.73	73 70	17.23	76.4	.796	72.4	70	...	4.22	1.40
Johore, Johore Bahru	...	...	...	89.26	73.63	...	...	...	...	...	...	11 85	1.88
Malacca, Durian Daun	1017.8	117.	82.	88.	74.	14.	78.	.958	...	85	N E.	7.67	1.36
Penang, George Town	1009 4	156.	82.3	93.5	70.	23.5	76.7	.844	72 9	77	N.W.	13.52	2.32
Kedah, Alor Star	...	...	...	...	...	.	...	...	...	...	...	9.42	.191
Perlis, Kangar	...	...	...	89.26	73 90	15.36	...	...	...	...	...	8.41	1.28
May—													
Kelantan, Kota Bahru	...	141.	83 60	93.13	74.10	19.03	76.60	.782	71.9	68	...	3.33	1.09
Johore, Johore Bahru	...	..	..	89.19	74.67	.	...	...	...	...	...	10 94	2.70
Malacca, Durian Daun	1017.7	115.	83	89.	74.	15.	79.	.963	...	81	N.E.	8.02	3.50
Penang, George Town	1008.2	161.	82.4	93.	71.	22.	76.8	.235	73.1	75.9	S.	3.28	2.12
Kedah, Alor Star	...	...	...	...		...	...	...	...	...	...	12.20	3.22
Perlis, Kangar	...	...	...	90.19	74 84	15.35	...	...	...	...	...	5.50	1.82
June—													
Kelantan, Kota Bahru	...	149.	83.10	92.90	74 40	19.40	77.	.810	72.9	71	...	3.43	.85
Johore, Johore Bahru	...	...	...	88.66	74.[illegible]0	...	...	...	...	...	...	9.22	1 94
Malacca, Durian Daun	1018.1	115.	82.	88.	74.	14.	80.	.951	...	85	N.E.	7.86	1.65
Penang, George Town	1008.9	158.	82 3	91.5	70.	21.5	76.	.814	71.8	74.3	S.	12.00	4.32
Kedah, Alor Star	...	...	...	...		...	...	...	...	...	...	4.40	.86
Perlis, Kangar	...	...	...	88.40	73.87	14.53	...	...	...	...	...	7.89	1.50

Abstract of Meteorological Readings in the various Districts of Malaya for the 1st Quarter of 1925.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 21 hours.
JANUARY—													
Kelantan, Kota Bahru	...	143.9[illegible]	79.30	85.74	72.83	12.90	73.80	.733	70.	73	...	11.48	2.95
Johore, Johore Bahru	...	...	...	86.35	71.93		.	.	...	...	...	21.11	6.25
Malacca, Durian Daun	1017.8	119.	82.	87.	73	14.	78.	.921	..	83	N E.	9.54	3.48
Penang, George Town	1009.	154	82.	93.	69.	24.	78.90	.940	70.10	85	N.W.	4.64	1.20
Kedah, Alor Star	...	...	...	...	...	...	...	...	..	...	...	3.19	1.11
Perlis, Kangar	...	...	...	87.16	71.29	15.87	.	...	...	...	...	1.76	.33
FEBRUARY—													
Kelantan, Kota Bahru	...	141.	77.	85.20	71.10	14.10	73.60	.751	70.70	79	...	1.75	.75
Johore, Johore Bahru	...	...	...	84.92	71.60	...	...	...	...	...	...	18.68	3.55
Malacca, Durian Daun	1018.1	117.	81.	87.	73.	14.	77.	.886	...	82	N E.	5.04	1.60
Penang, George Town	1009.2	160.	82.1	94.	69.	25.	74.7	.749	69.7	69.7	N.W.	3.44	2.60
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	.66	.26
Perlis, Kangar	...	...	...	88.57	70.43	18.14	..	...	...	...	...	.90	.60
MARCH—													
Kelantan, Kota Bahru	...	141.	81.20	88.50	73.80	14.70	75.20	.761	71.1	72	...	4.72	1.70
Johore, Johore Bahru	...	...	...	87.90	72.64	...		...	...	...	...	7.75	1.33
Malacca, Durian Daun	1018	121.	83.	89.	73	16.	78.	.919	..	79	N.	3.78	1.16
Penang, George Town	1006.2	164.	81.2	94.	68.	26.	75.2	.796	71.1	75.8	N.W.	20.24	4.76
Kedah, Alor Star	...	...	...	...	...	..		...	...	..	...	11.44	2.73
Perlis, Kangar	...	...		89.22	72.26	16.96	...	...	...	...	...	5.79	1.42

Abstract of Meteorological Readings in the various Districts of Malaya for the 3rd Quarter of 1925.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature: Mean Dry Bulb.	Temperature: Maximum.	Temperature: Minimum	Temperature: Range.	Hygrometer: Mean Wet Bulb.	Hygrometer: Vapour Tension.	Hygrometer: Dew Point.	Hygrometer: Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
July—													
Kelantan, Kota Bahru -	...	141.	84.5	91.90	73.51	18.39	75.90	.738	70.20	62	...	4.76	1 15
Johore, Johore Bahru -	...	...	...	86.93	73.41		.	..	...	...	...	1.76	.50
Malacca, Durian Daun -	1018 5	112.	82.	88.	73	15.	78	.937	...	82	N.E.	9 80	2.60
Penang, George Town -	1009.9	157.	83.	93.	70.	23.	75.9	.798	71.1	71.1	S.	5.44	1.60
Kedah, Alor Star -	...	...	...	...	...	...	...	...	...	...	...	4.13	.71
Perlis, Kangar -	...	...	81.74	89.03	74.39	14.64	78.32	...	...	...	...	5 03	2.10
August—													
Kelantan, Kota Bahru -	...	142.42	83.	91.80	73.58	18.22	75.8	.759	71.	67	...	6 33	1.17
Johore, Johore Bahru -	...	...	...	86.48	73.06	...	...	...	...	...	...	1.18	.38
Malacca, Durian Daun -	1018.3	117.	82.	88.	74.	14.	78.	.933	...	81	N.E.	11.14	3.33
Penang, George Town -	1009.2	155.	82.6	92.	70.	22.	75 9	.803	71.4	72.8	S.	9.08	2 32
Kedah, Alor Star -	...	...	...	...	...	...	...	...	...	...	...	9.88	2.45
Perlis, Kangar -	...	...	82.03	88.58	74 64	13.94	29.09	...	...	...	...	9.79	2.42
September—													
Kelantan, Kota Bahru -	...	146.23	83.70	92.70	73.90	18.80	75.80	.746	70.5	64	...	6.12	1.80
Johore, Johore Bahru -	...	...	...	85 50	72.85	...	..	...	...	...	...	4.62	1.12
Malacca, Durian Daun -	1018.4	119.	83.	89.	74.	15.	78.	.936	...	81	N.E.	8.00	2.90
Penang, George Town -	1010.5	157.	82.1	92.	69.5	22.5	76.5	.834	72.7	76	N.W.	12.92	1.52
Kedah, Alor Star -	...	...	...	...	...	...	.	...	...	...	...	4.25	.86
Perlis, Kangar -	...	...	83 30	89.73	73.66	16 07	79 26	...	...	...	...	5.08	2.75

Abstract of Meteorological Readings in the various Districts of Malaya for the 4th Quarter of 1925.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Maximum.	Minimum.	Range.	Hygrometer. Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
October—													
Kelantan, Kota Bahru -	...	145.16	80 70	89 26	73 83	15.41	75.10	.766	71.30	73	...	12.13	1 24
Johore, Johore Bahru -	...	...	...	86 24	73.45	...	...	...	...	...	...	3 99	.88
Malacca, Durian Daun -	1018.5	113.	83.	88.	74.	14.	79.	.961	...	84	N.W.	11.43	1.29
Penang, George Town -	1011 3	157.	80.10	92.	69.50	22.50	76.30	.841	73.70	79.6	N.W.	39.60	9.20
Kedah, Alor Star -	...	...	...	...	...		...	...	...	...	...	15.34	3.08
Perlis, Kangar -	...	...	81.12	86 83	73 29	13.54	78 03	...	...	...	...	8 92	2.57
November—													
Kelantan, Kota Bahru -	...	..	77.90	84 33	73.40	10.93	73 80	.759	71.	79	...	43 97	4.40
Johore, Johore Bahru -	...	...	...	85.90	73 16	..	...	...	...	...	...	1 36	.68
Malacca, Durian Daun -	1018.5	108.	83	88.	74	14.	79.	.963	...	84	...	8.33	1 37
Penang, George Town -	1010.9	157.	82.5	92.	69.	23.	76 5	833	72.50	76.3	N.E.	19.	4.52
Kedah, Alor Star -	...	...	..	...		...	...	...	...	...	...	13 72	2 50
Perlis, Kangar -	...	.	81 09	86 20	73.73	12.47	78.04	...	...	...	...	6 29	1 10
December—													
Kelantan, Kota Bahru -	...	134.50	79 40	85 90	73 54	12 36	74	.738	70 2	73	...	14.72	3 35
Johore, Johore Bahru -	...	...	...	82.74	72 64		...	...	...	...	...	7 87	1 31
Malacca, Durian Daun	1020 1	106.	83	88.	73.	15	79	.953	...	83	...	10.44	1 77
Penang, George Town -	1011.6	161.	82 90	93.	70	23.	76 50	.827	72.70	74 3	N W.	4 20	1.40
Kedah, Alor Star -	...	...		...			...	...	...	...	...	2 10	.70
Perlis, Kangar -	...	...	83.22	88 19	74 22	12.97	75.7	...	...	...	...	3 17	2.09

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, JANUARY, 1925.

Station.	Air Temperature in degrees Fahrenheit. Means. 9 A.M.	3 P.M.	9 P.M.	Maximum.	Minimum.	Max. in Sun (Black bulb in vacuo)	Minimum on grass.	Absolute Extremes. Highest max.	No. of days.	Lowest min.	No. of days.	Lowest max.	No. of days.	Highest min.	No. of days.	Humidity. Means. Depression of Wet Bulb. 9 A.M.	3 P.M.	9 P.M.	Vapour Pressure. 9 A.M.	3 P.M.	9 P.M.	Percentage. 9 A.M.	3 P.M.	9 P.M.	Rainfall. Total		Most in a day. Amount.	Date.	No. of rainfall days.	Bright Sunshine. Daily mean.	Total.
																			m.b.	m.b.	m.b.	%	%	%	In.	m.m.	m.m.			Hrs.	Hrs.
PERAK—																															
Taiping	79,5	82,2	76,8	87,2	72,2	153,0	67,3	90	2	69	1	84	1	75	1	3,7	4,9	1,5	27,7	28,3	28,7	83	79	93	17,51	445,5	58,5	12th	21	...	
Kuala Kangsar	76,7	85,3	75,5	88,6	72,2	...	...	92	1	68	1	83	1	76	1	2,9	8,5	0 9	26,3	25,9	28,4	86	66	96	5 94	151,0	45,5	31st	16	...	...
Batu Gajah	78,3	85,8	77,4	88,1	72,2	152,3	...	92	1	69	1	83	1	76	1	3,5	6,9	2,0	26,9	28,8	28,4	84	72	91	14,94	379 5	67 0	15th	17	...	..
Gopeng	79,4	85,9	78,4	87,6	70,2	...	...	91	5	?	...	82	1	73	2	5,1	9,2	2,9	25,4	25,3	27,0	78	64	86	9,35	237,5	49 0	15th	14	...	...
Ipoh	78,9	86,1	75,6	89,2	71,5	...	...	94	1	68	1	85	1	75	1	3,7	8,2	1,0	27,1	27,1	28,3	83	68	95	7,48	190,0	48,5	13th	15	...	...
Kampar	78,5	84,4	75,7	87,5	71,3	...	...	90	6	68	3	82	2	79	2	3,9	7,5	1,4	26,4	26 5	27,7	82	70	93	13,57	341,7	59,0	31st	15	...	...
Teluk Anson	77,5	85,5	76,9	87,1	71,7	...	...	92	1	69	1	81	1	75	2	2 1	7,2	1,5	28 8	28,0	28,8	91	71	93	15,37	390,4	51,8	11th	20	...	...
Tapah	76,4	83,9	77,1	86,0	...	...	...	89	3	...	...	82	1	...	...	2,0	7,3	0,1	25,3	26,4	30,7	90	70	98	14,91	379,4	77,5	18th	20	...	.
Parit Buntar	81,3	86,6	77,5	90,1	71,1	...	...	92	4	70	5	89	12	74	1	3,8	8,1	1,3	29,2	27,7	29,6	84	69	94	11 40	289,6	39 0	15th	20	...	..
Bagan Serai	78,1	84,7	74,7	86,7	72,5	...	...	89	2	70	3	85	4	75	1	1,8	6,7	0,8	29,3	28,1	27,7	92	73	96	11 46	291,0	15,0	6th	13	...	..
Selama	78,4	84,9	75,6	85,5	72,6	...	...	88	5	71	4	82	4	74	1	2,2	5 9	1 1	29 0	29,5	28,1	90	76	95	20 31	516 0	87,0	15th	23	...	..
Lenggong	76,6	84,6	76,0	86,8	70,5	...	...	90	1	66	1	85	6	74	2	2,9	7,3	1 5	26,2	27 0	27 8	86	70	93	11,19	360 5	89,0	13th	17	...	...
Tanjong Malim	80,2	86,3	75,7	89,5	71,1	...	...	92	1	67	1	85	2	75	1	2 7	6,5	1 0	30,0	29 9	28,4	88	74	95	8,50	216,0	57 5	18th	16	...	
Grik	76,4	87,8	75,0	89,6	69,8	...	..	93	4	64	1	82	1	72	6	...	..	...	...	..	...	...	...	..	12,02	305 3	155 0	31st	16	...	..
Klian Intan	71,7	82,7	72,1	84,9	68 3	...	...	89	3	63	2	77	1	71	3	3,2	8 2	2 6	21,2	21 0	22 8	85	67	87	6,83	173,6	98 0	31st	12	...	...
Kroh	75,8	82,0	70,6	83,8	68,5	...	...	91	2	64	2	77	1	71	2	3,8	9,6	0 9	24,2	21,6	24 0	82	62	95	8 82	221,0	145 1	31st	12	...	...
Tanjong Rambutan	...	...	...	86,5	73,7	...	...	92	1	68	1	79	1	79	2	...	...	.	...	...	...	..	...	...	12 86	326 6	53 3	16th	12	...	.
Sitiawan	79,9	84,5	75,4	87,9	71,7	...	...	91	1	69	1	81	1	71	1	3,1	6 1	0,8	28,6	29 9	28,1	85	75	96	10,76	273,4	77,5	12th	11	...	...
SELANGOR—																															
Lake Gardens, Kuala Lumpur	78,9	84,9	75,6	89,2	70,7	153,2	69,9	93	1	66	1	79	1	71	1	4,4	9,1	1,6	26 1	24 7	27 3	81	65	93	8 72	221 4	71 5	31st	16	5,28	163,75
General Hospital	79,0	84,7	76,0	87,8	71,8	147,4	70,4	92	1	68	1	80	1	75	1	4,7	8,8	2,1	25 7	25 0	26 9	79	67	90	9 09	231 2	68 2	31st	18	.	...
Klang	78,2	81,0	77,3	84,6	73,3	...	...	89	1	71	2	81	3	78	1	3,6	6,1	2 0	26 6	27 8	28,4	84	74	91	10,56	268,2	62,0	31st	12	...	.
Kajang	...	...	...	90,1	72,3	...	...	94	3	70	3	85	1	71	6	...	...	..	..	..	.	..	...	...	7,96	202,2	77 1	31st	15	..	...
Kuala Selangor	...	...	...	89,2	...	...	...	92	1	...	...	87	3	..	...	...	...	...	...	...	...	...	..	...	6 77	172 0	34,0	8th	9	...	..
Serendah	...	...	...	86,9	70 9	...	...	90	7	67	1	83	2	73	2	...	..	..	...	..	...	...	...		8,87	225,4	51,1	31st	18	...	...
Kuala Kubu	...	...	...	89,1	71,2	...	...	92	4	68	2	84	1	71	2	...	...	.	..	..	...	..	...	...	1,91	121,6	11,5	31st	13	.	...
Telok Datoh	...	...	...	86,3	71,7	...	...	89	4	69	2	82	1	75	1	...	...	..	...	..	..	...	...	.	9,23	234 4	58 1	31st	15	...	.
NEGRI SEMBILAN—																															
Seremban	79,6	82 9	78,1	88,1	72,8	...	68,1	91	4	70	2	86	8	76	2	3,4	5 4	2,0	28 3	28 3	29 0	84	77	91	9 67	191 8	52,8	31st	10	..	
Kuala Pilah	78 3	83,8	76,2	86,3	68,9	...	...	92	1	66	1	79	1	72	2	3 5	7,5	2 0	26 9	26 0	27,2	84	69	90	12 39	314 7	69,1	12th	15	...	
Tampin	79 2	82,5	76,9	88,1	70,5	143,2	...	91	4	68	3	83	1	75	1	3 8	6 0	2,0	27 2	27 0	27,9	83	75	91	11 81	299,9	76,5	31st	11	...	..
Port Dickson	78 4	82,7	78 0	85,3	73 2	150,5	...	88	2	70	1	84	.	75	2	3 2	5 2	2,9	29,3	2 ,1	27 5	85	78	86	7 20	182 8	58,6	31st	11	...	...
Jelebu	79,3	81,1	78,2	84,4	70,8	...	...	88	3	67	1	80	1	73	2	3,8	4,1	3 5	27 3	28,1	26,8	83	81	84	6,84	173 8	79,4	31st	8	...	...
PAHANG—																															
Kuala Lipis	77,0	83,1	75,8	85,5	70,9	...	...	89	3	69	5	79	1	75	1	2 8	7,3	1 6	26,7	27,5	27,5	87	70	92	21 63	549 1	101,1	30th	19	..	...
Raub	76,4	82,6	73,7	85,6	71,0	148,5	69,6	89	1	67	1	83	2	73	3	3,2	6 6	1,3	25,5	26,0	26,1	85	73	94	9 12	231 7	46,5	31st	15	.	..
Bentong	75,9	81,3	74,5	84,7	72,1	...	..	90	1	68	2	76	1	74	2	2,6	5,9	0 8	26,1	26,0	27,5	88	74	96	9 88	250,9	33,0	18th	18	..	..
Pekan	79,9	82,0	76,8	82,9	71,6	...	...	89	1	70	2	80	5	74	1	2 5	3,5	1 4	30,0	30,5	28,8	89	85	93	12 42	315 5	79,0	15th	14	...	...
Kuantan	78,6	82,3	75,7	85,0	71,6	...	...	89	1	69	6	81	1	75	1	3,5	5 7	1,8	27 1	27,2	27,0	84	76	91	9,66	235 4	67,8	12th	16	...	:
Sungei Lembing	...	...	...	83,0	70,3	...	...	89	1	66	4	76	1	74	1	...	...	...	...	...	...	..	...	...	17,71	...	65,5	12th	20	...	...
Camerons H'lands (Tanah Rata)	59,5	68,8	61,1	70,3	51,8	133,0	52,5	75	1	47	1	65	1	60	1	1 0	5 3	1,0	16,7	17,1	17,0	94	75	94	11,60	294 7	72 8	12th	21	3 85	119,35
" " (Rhedn Hill)	60,8	67,0	...	69 4	56,6	135,9	55,8	77	1	53	1	63	2	59	1	2,2	4,3	...	16,0	17,1	...	88	80	...	12,11	307,5	76,2	12th	21	4,07	126,05
Fraser's Hill	62,3	67,8	63,1	69,9	60,8	...	...	77	1	58	1	64	1	65	2	0,7	3,2	0 6	18,1	18,9	18,8	96	85	97	17,39	441 7	67,3	7th	21	3,03	93,80

RAINFALL STATIONS

Perak —	Total.		Most in a day.	Date.	No. of rainfall days.	—	Total.		Most in a day.	Date.	No. of rainfall days.	Selangor. —	Total.		Most in a day.	Date.	No. of rainfall days.	Negri Sembilan. —	Total.		Most in a day.	Date.	No. of rainfall days.	Pahang. —	Total.		Most in a day.	Date.	No. of rainfall days.
	In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.		
Kuala Kurau	11,04	280,4	57,9	17th	18	P. Tanjong	14,81	376,3	63,7	31st	14	Sabak Pernam	12,01	305,1	51,6	8th	15	Mantin	6,11	155,3	52,6	31st	11	Temerloh	12,31	312,7	77 7	12th	16
The Cottage	19,64	498,9	62,2	15th	21	Bagan Datoh	4,60	116,8	27,4	12th	14	Dist. Hospital K. L.	6,46	164,1	74,5	31st	14							K. Tembeling	8,32	211 3	65,5	12th	21
Maxwell'sHill	17,54	435,5	54,6	15th	20	Sungkai	10,75	273,0	60,0	13th	15	Prisons, K. L.	8,07	205,1	31,6	31st	17							Rompin	13,98	355,1	159,3	12th	14

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, FEBRUARY, 1925.

Station.	Air Temperature in degrees Fahrenheit. Means. 9 A.M.	3 P.M.	9 P.M.	Maximum.	Minimum.	Max. in Sun (black bulb in vacuo.)	Minimum on grass.	Absolute Extremes. Highest max.	No. of days.	Lowest min.	No. of days.	Lowest max.	No. of days.	Highest min.	No. of days.	Humidity. Means. Depression of Wet Bulb 9 A.M.	3 P.M.	9 P.M.	Vapour Pressure. 9 A.M.	3 P.M.	9 P.M.	Percentage. 9 A.M.	3 P.M.	9 P.M.	Rainfall. Total.		Most in a day. Amount.	Date.	No. of Rainfall days	Bright Sunshine. Daily mean.	Total.
	°	°	°	°	°	°	°	°		°		°		°		°	°	°	m.b.	m.b.	m.b.	%	%	%	In.	m.m.	m.m.			Hrs.	Hrs.
PERAK—																															
Taiping	79.7	83.3	77.9	87.8	71.9	152.2	67.4	92	1	70	2	79	1	75	1	4.2	6.0	2.3	27.1	27.7	28.6	81	75	90	12.64	321.0	47.0	20th	19	...	...
Kuala Kangsar	75.5	86.5	75.5	89.4	71.8	...	...	93	4	69	2	81	1	75	2	2.2	9.7	1.1	26.2	25.2	28.0	89	63	95	6.14	156.0	76.0	12th	11	...	...
Batu Gajah	78.0	87.2	77.1	88.8	72.0	...	...	93	5	69	1	79	1	75	2	3.4	8.9	1.9	26.8	27.0	28.3	85	65	91	6.08	154.5	30.5	20th	14	...	...
Gopeng	79.2	86.5	77.7	88.4	71.0	...	...	94	1	68	2	82	1	74	3	5.2	9.8	2.9	25.1	25.0	27.2	77	62	86	9.09	231.0	73.0	14th	15	...	...
Ipoh	78.9	87.9	75.7	89.8	71.4	...	...	95	2	69	1	80	1	74	1	4.1	9.9	0.6	26.4	26.1	29.0	82	63	97	7.44	189.0	35.7	6th	15	...	...
Kampar	77.3	85.1	74.7	87.4	72.1	...	...	92	2	68	1	78	1	77	1	2.9	7.5	0.9	26.9	27.1	27.6	86	70	96	9.55	242.6	29.2	17th	23	...	...
Teluk Anson	77.7	86.3	77.4	87.8	72.2	...	...	91	3	70	1	80	1	74	3	2.1	8.1	1.9	28.6	27.3	28.6	91	68	91	7.23	183.5	53.8	1st	14	...	...
Tapah	76.4	82.5	76.9	86.1	71.6	...	...	91	2	68	1	80	2	75	1	2.3	5.9	0.3	27.0	27.1	30.7	90	75	99	11.63	295.4	51.7	20th	23	...	...
Parit Buntar ...	82.0	88.0	77.5	86.5	71.3	...	...	92	5	70	2	89	12	72	11	4.2	8.2	1.5	29.3	28.9	29.3	82	68	93	4.93	125.3	57.6	15th	9	...	...
Bagan Serai	79.1	85.6	76.0	87.6	72.2	...	...	91	1	70	2	82	1	79	1	3.6	7.7	2.0	27.5	27.3	27.0	84	69	90	5.71	145.0	49.0	16th	8	...	...
Selama	77.8	86.5	76.3	86.8	72.9	...	...	91	1	70	1	84	1	76	1	2.3	7.3	1.2	28.3	28.9	28.7	89	71	94	5.85	148.5	62.0	5th	7	...	...
Lenggong	75.7	86.4	75.9	87.5	69.0	...	...	90	7	67	3	83	2	74	1	2.7	9.3	1.7	25.7	25.7	27.3	87	64	92	1.91	48.5	13.5	12th	6	...	...
Tanjong Malim	79.5	86.2	75.8	88.8	70.8	...	...	92	3	68	1	85	2	74	1	2.6	6.5	1.1	29.5	29.8	28.4	89	74	95	8.64	219.5	64.0	24th	17	...	...
Grik	74.9	87.6	75.1	89.5	69.0	...	...	93	3	65	1	83	1	73	1	2.6	8.3	1.7	25.2	23.4	26.8	88	68	92	2.60	66.0	36.5	20th	10	...	...
Klian Intan	74.2	84.8	73.0	85.7	66.9	...	...	90	3	64	5	80	2	71	1	3.3	10.6	1.7	25.6	22.6	23.4	84	59	87	1.02	25.8	11.0	20th	6	...	...
Kroh	75.1	82.5	70.7	85.3	67.4	...	...	91	1	65	8	79	1	70	2	4.3	9.5	0.9	22.9	22.1	24.1	80	62	95	1.25	31.8	8.5	20th	7	...	...
Tanjong Rambutan ...	79.7	86.2	75.3	88.7	72.5	...	...	93	3	70	1	81	1	75	3	5.1	8.7	2.7	25.7	26.3	25.4	78	66	87	2.70	68.6	26.0	13th	4	...	...
Sitiawan	80.4	85.2	75.6	87.7	71.8	...	...	90	2	70	3	79	1	73	8	3.4	7.2	1.0	29.0	28.0	28.3	85	71	95	12.78	324.7	91.7	20th	9	...	...
SELANGOR—																															
Lake Gardens, Kuala Lumpur	78.3	85.1	74.9	88.9	70.1	154.5	69.7	93	1	66	1	84	2	73	1	3.9	9.0	1.5	26.2	25.0	26.4	83	65	93	7.42	188.4	49.3	6th	18	4.91	137.55
General Hospital ...	78.4	84.5	75.6	87.8	71.5	150.8	70.2	92	1	69	2	82	1	74	1	4.3	8.1	2.1	25.7	25.6	26.5	81	68	90	5.85	148.7	28.8	6th	16	...	...
Klang	77.1	82.6	75.6	82.1	73.0	...	...	87	1	70	1	79	2	75	1	2.5	5.9	1.4	27.3	27.2	27.6	88	75	93	3.91	99.4	24.0	14th	11	...	...
Kajang	...	...	...	88.8	72.9	...	...	93	4	71	3	82	1	76	1	...	...	...	...	...	...	..	...	..	8.47	215.0	50.2	5th	18	...	...
Kuala Selangor	...	...	...	88.7	...	...	...	91	1	...	...	84	1	...	...	...	...	...	...	..	...	...	...	...	7.78	197.0	66.4	19th	11	...	...
Serendah	...	...	...	86.8	70.3	...	...	91	3	68	2	82	1	73	2	...	...	...	...	...	..	..	...	...	5.84	148.3	29.7	6th	18	...	..
Kuala Kubu	...	...	...	88.0	71.1	...	...	94	1	67	1	82	1	73	1	..	...	...	...	...	...	...	...	...	5.13	130.4	41.3	11th	15	...	...
Telok Datoh	...	...	...	86.0	71.7	...	...	89	2	70	4	82	2	74	1	...	...	...	...	...	...	...	...	...	5.72	145.3	26.0	6th	19	...	...
NEGRI SEMBILAN—																															
Seremban	78.6	82.8	77.2	88.5	72.1	...	67.5	92	2	70	1	82	1	75	1	3.8	5.0	1.3	25.8	28.9	29.3	83	79	94	6.00	152.4	35.0	10th	13	...	...
Kuala Pilah	77.6	83.8	76.0	85.7	69.0	...	...	90	3	67	4	79	3	72	2	3.8	8.1	1.9	25.8	25.1	27.1	83	68	91	8.20	208.2	74.0	12th	12	...	...
Tampin	78.5	85.3	76.3	87.9	70.5	142.0	...	92	2	69	3	82	1	76	1	4.0	8.1	2.4	26.2	26.4	26.7	82	68	88	1.69	43.0	8.6	5th	7	...	...
Port Dickson	78.6	82.7	78.4	84.6	72.9	154.5	...	87	1	72	9	82	1	75	1	3.7	5.4	3.6	26.8	28.1	26.8	83	77	84	3.35	85.0	23.8	10th	12	...	...
Jelebu	78.6	80.7	77.9	84.2	70.5	...	...	87	2	67	1	80	2	73	1	2.7	2.5	1.6	28.3	30.8	29.5	88	89	93	1.76	44.6	27.2	12th	4	...	...
PAHANG—																															
Kuala Lipis	76.0	83.1	75.7	84.9	69.5	...	...	90	2	66	1	79	2	71	7	2.6	7.4	1.7	26.1	25.4	27.2	88	69	92	5.94	150.9	31.0	1st	15	...	...
Raub...	75.8	82.7	74.2	84.9	71.1	146.2	69.6	89	1	68	1	80	1	74	1	3.2	7.5	1.5	25.1	25.0	26.2	85	69	93	4.55	115.6	26.2	1st	13	...	...
Bentong	75.6	82.9	73.2	84.9	71.9	...	...	91	1	67	1	77	1	74	4	2.2	7.1	1.1	26.3	27.7	27.7	89	71	95	6.20	157.5	30.7	6th	16	...	...
Pekan	78.5	80.6	76.4	83.2	71.7	...	...	85	9	67	1	79	1	74	4	3.3	4.2	1.1	27.3	27.9	28.2	85	81	95	14.03	356.4	59.2	4th	12	...	...
Kuantan	77.4	81.5	75.4	84.1	70.9	...	...	87	2	67	3	80	2	75	1	3.3	5.8	2.2	26.3	26.2	26.2	85	76	89	8.45	214.6	48.3	20th	14	...	...
Sungei Lembing ...	...	...	..	82.3	69.1	...	..	87	2	65	1	72	1	76	1	...	...	...	...	...	...	..	...	...	9.32	236.7	97.5	19th	17	...	...
Camerons H'lands (Tanah Rata)	59.2	68.1	60.8	70.3	53.8	131.0	52.0	75	2	42	1	64	1	59	2	1.0	4.5	1.0	15.9	17.5	17.4	94	78	94	6.05	153.6	31.5	20th	15	3.70	103.50
" " (Rhodn. Hill)	60.8	66.2	...	69.5	56.8	136.0	55.2	77	1	55	3	61	1	59	1	2.4	3.6	...	15.3	17.3	...	87	82	...	5.19	131.9	30.1	21th	15	3.82	107.05
Fraser's Hill	61.7	67.9	63.0	70.1	60.7	...	...	76	1	57	1	61	1	63	2	0.8	3.6	0.8	17.6	18.4	18.4	95	82	95	9.82	249.4	61.0	20th	19	3.97	111.10

RAINFALL STATIONS

Perak.												Selangor.						Negri Sembilan						Pahang.					
—	Total.		Most in a day.	Date.	No. of rainfall days.	—	Total.		Most in a day.	Date.	No. of rainfall days.	—	Total.		Most in a day.	Date.	No. of rainfall days.	—	Total.		Most in a day.	Date.	No. of rainfall days.	—	Total.		Most in a day.	Date.	No. of rainfall days.
	In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.		
Kuala Kurau	5.55	141.0	43.8	1st	11	P. Tanjong	5.88	149.3	38.7	11th	11	Sabak Pernam	7.68	195.0	54.7	20th	13	Mantin	7.43	188.7	33.2	5th	16	Temerloh	4.76	120.9	24.9	6th	13
The Cottage	8.11	206.0	35.1	13th	14	Bagan Datoh	5.18	131.5	39.5	20th	10	Dist. Hospital, K.L.	6.29	159.8	54.2	16th	21							K. Tembeling	8.41	213.6	57.7	20th	15
Maxwell's Hill	11.73	297.9	65.3	1st	17	Sungkai	7.56	192.0	69.0	20th	12	Prisons, K.L.	9.07	230.4	64.2	6th	17							Rompin	17.7.	150.1	83.3	8th	14

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, MARCH, 1925.

Station.	Air Temperature in degrees Fahrenheit. Means. 9 A.M.	3 P.M.	9 P.M.	Maximum.	Minimum.	Max. in Sun (Black bulb in vacuo).	Minimum on grass.	Absolute extremes. Highest max.	No. of days.	Lowest min.	No. of days.	Lowest max.	No. of days.	Highest min.	No. of days.	Humidity. Means. Depression of Wet Bulb 9 A.M.	3 P.M.	9 P.M.	Vapour Pressure 9 A.M.	3 P.M.	9 P.M.	Percentage 9 A.M.	3 P.M.	9 P.M.	Rainfall. Total.		Most in a day. Amount.	Date.	No. of rainfall days.	Bright Sunshine. Daily mean.	Total.
	°			°	°	°	°	°		°		°							m.b.	m.b.	m.b.	%			In.	m.m.	m.m.			Hrs.	Hrs.
PERAK—																															
Taiping	80,4	82,5	76,8	88,5	72,5	155,9	68,0	92	1	68	1	85	1	76	1	4,1	5,3	1,8	27,0	28,0	28,1	82	78	92	26,87	682,5	112,0	12th	26	...	
Kuala Kangsar	76,4	84,0	75,1	89,7	72,6	...	...	92	6	69	1	78	1	75	1	1,9	6,9	0,9	27,5	27,0	28,0	91	71	96	10,69	271,5	59,0	12th	20	...	
Batu Gajah	78,8	85,4	76,8	89,8	72,1	159,9	...	93	1	68	1	77	1	74	3	3,4	7,0	1,8	27,5	28,3	28,1	84	72	92	11,77	298,9	56,7	21th	19	...	
Gopeng	79,5	84,5	76,9	89,5	71,1	...	...	92	1	68	1	87	2	75	2	5,1	8,2	2,1	25,5	25,6	27,2	78	67	88	17,21	137,0	80,5	12th	21	...	
Ipoh	79,1	84,1	75,3	90,3	71,7	...	...	94	3	68	1	79	1	75	1	3,5	6,8	0,3	27,6	26,3	29,1	81	72	99	17,78	151,5	76,4	19th	27	...	
Kampar	78,0	83,5	74,1	88,3	72,0	...	...	91	4	68	1	84	1	75	1	2,9	6,3	1,7	27,5	27,4	25,8	86	71	92	21,60	621,8	120,6	24th	29	...	...
Teluk Anson	78,5	85,5	76,7	88,8	72,2	...	...	93	2	68	1	86	3	75	1	2,3	7,3	1,0	28,9	27,8	29,3	90	71	95	9,60	243,7	59,8	10th	20	...	...
Tapah	78,0	82,7	76,7	87,2	73,1	...	...	91	1	68	1	83	1	78	1	3,0	6,3	0,9	27,3	26,7	29,5	86	71	96	25,38	644,7	99,3	17th	27	...	...
Parit Buntar	81,0	85,2	77,7	89,7	72,1	...	...	92	3	69	1	88	3	75	1	3,9	6,6	1,5	28,9	28,7	29,5	83	71	93	15,71	399,0	54,3	15th	20	...	...
Bagan Serai	80,4	85,8	75,5	87,7	72,7	...	...	90	1	70	4	81	1	75	2	3,5	8,3	1,8	28,6	26,6	26,9	85	67	91	22,03	559,5	226,5	15th	18	...	..
Selama	78,0	83,1	75,5	87,1	73,0	...	...	90	3	70	1	81	1	76	1	3,3	5,6	1,2	26,9	28,5	27,8	85	77	94	24,80	630,0	110,0	16th	25	...	...
Lenggong	77,0	85,3	75,7	89,0	71,7	...	...	91	3	67	2	86	1	74	5	2,6	8,2	1,5	27,0	26,3	27,4	88	67	93	8,92	226,5	32,0	7th	18	...	...
Tanjong Malim	81,2	84,3	75,6	89,1	71,4	...	...	92	2	69	3	85	1	75	1	3,8	5,7	1,9	29,1	29,1	26,8	84	77	91	16,50	119,0	133,0	13th	21	...	
Grik	77,7	85,4	77,7	91,5	70,8	...	...	94	4	66	1	86	2	75	1	3,3	2,7	2,2	26,6	35,7	26,4	85	89	89	10,13	257,2	57,0	29th	21	...	...
Klian Intan	55,5	82,2	72,1	86,2	69,3	...	...	90	3	63	1	80	2	73	1	2,6	7,5	1,7	25,6	25,1	24,9	88	69	91	12,26	311,5	54,4	30th	18	...	...
Kroh	76,3	82,6	70,3	86,2	69,7	...	...	91	2	66	2	80	1	72	4	3,5	12,1	1,9	25,0	19,1	22,3	81	55	90	10,02	254,6	47,0	15th	20	...	...
Tanjong Rambutan	...	...	...	..	.	...	...	...	...	...	...	...	...	...	...	...	...	...	..	...	...	..	..		13,55	344,1	46,0	27th	28	...	
Sitiawan	[illegible]	85,6	75,4	88,6	72,1	...	...	90	2	70	2	87	2	75	1	3,5	6,7	0,7	29,8	28,9	28,6	85	73	97	1,81	122,3	16,9	21st	7	...	
SELANGOR—																															
Lake Gardens, Kuala Lumpur	79,0	81,8	75,6	89,8	71,0	154,2	70,5	92	7	67	1	83	1	73	5	3,6	8,3	1,2	27,3	25,7	27,9	81	67	91	11,39	289,3	57,5	4th	21	5,33	165,20
General Hospital	79,2	84,4	76,1	88,7	72,3	152,6	71,1	92	1	69	1	86	3	75	1	4,2	7,9	1,8	26,6	25,9	27,1	81	68	91	12,74	323,7	67,9	13th	21	...	...
Klang	78,0	82,5	76,9	84,2	73,5	...	...	87	2	70	2	80	1	77	2	2,8	9,5	1,6	27,7	22,9	28,6	87	62	93	9,33	237,1	138,4	22nd	13	...	.
Kajang	...	...	..	89,6	72,3	...	...	94	2	70	2	86	3	71	1	...	...	..	..	...	...	..	.	..	8,87	225,3	27,1	24th	21	...	...
Kuala Selangor	...	...	...	89,8	.	..	..	91	5	...	..	88	1	...	...	...	.	..	...	..	..	..	..	...	3,31	84,7	21,1	22nd	8	...	..
Serendale	...	...	...	87,6	69,0	...	...	91	1	65	2	84	1	74	7	...	...	..	...	..	...	..	...	.	15,79	401,1	67,2	15th	22	...	...
Kuala Kubu	...	...	...	87,7	71,5	...	...	93	1	68	1	82	1	75	1	...	...	...	...	..	...	..	..	.	17,60	447,0	60,9	26th	22	...	...
Telok Datoh	...	...	...	86,7	72,1	...	...	89	3	69	2	85	9	71	6	...	...	...	...	..	...	.	...	..	7,59	192,7	70,6	11th	16	...	...
NEGRI SEMBILAN—																															
Seremban	79,8	84,1	78,8	89,1	72,4	...	...	92	1	71	9	85	1	75	4	3,4	6,2	2,1	28,5	28,2	29,6	81	74	91	6,81	173,0	33,0	18th	11	..	
Kuala Pilah	78,7	86,0	76,7	88,4	69,6	...	...	92	2	67	1	83	1	73	2	3,7	12,3	1,4	26,9	21,4	28,7	81	55	93	12,29	312,2	75,8	31st	16	...	...
Tampin	80,1	87,8	77,4	89,7	69,6		...	91	3	69	11	87	1	70	20	4,6	[illegible]	2,0	26,9	27,2	28,1	80	68	91	11,31	287,2	55,8	13th	22	..	..
Port Dickson	79,3	83,9	79,1	85,4	73,5	154,1	..	88	3	72	4	84	13	75	1	2,7	5,2	1,3	27,4	29,6	27,0	83	78	81	8,06	204,8	50,4	24th	10	...	...
Jelebu	80,5	83,4	78,4	86,0	71,1	...	...	90	1	68	1	82	1	73	7	3,1	1,2	1,5	29,1	30,7	26,2	85	82	97	8,12	204,2	51,0	31st	9	...	...
PAHANG—																															
Kuala Lipis	77,5	86,5	76,5	88,3	70,9	...	...	91	2	68	1	85	1	74	1	3,1	,93	2,0	26,7	25,8	27,5	86	64	90	12,01	305,1	66,3	26th	25	..	...
Raub	77,2	81,6	74,7	87,1	71,5		70,8	91	1	69	2	83	1	74	3	2,8	8,1	1,0	26,9	25,8	27,4	87	68	95	10,39	263,9	35,1	17th	20	...	...
Bentong	76,3	84,7	75,5	87,6	72,3	...	..	92	1	67	1	82	1	75	2	2,3	5,2	1,0	26,9	27,2	28,2	89	71	95	11,05	280,9	66,3	13th	22	...	...
Pekan	79,7	83,1	77,5	85,1	72,8	...	...	89	1	69	2	81	1	75	1	3,0	5,0	1,2	29,0	29,1	29,8	87	79	91	11,61	371,1	116,8	12th	11	..	...
Kuantan	78,2	83,4	75,7	85,6	72,5	...	...	88	5	67	1	80	1	75	3	3,7	6,1	1,6	25,4	27,6	27,4	83	75	92	13,53	313,7	137,9	8th	21	..	..
Sungei Lembing	...	...	...	.	.	...	..	...	..	...	..	...	...	...	...	...	...	...	..	..	...	...	...	...	...	...	...	...	...	...	...
Camerons H'lands (Tanah Rata)	60,6	67,6	61,5	70,5	55,0	134,1	53,3	73	8	47	1	61	1	60	1	0,7	3,2	0,5	17,2	18,7	17,9	96	83	97	15,31	388,9	31,0	22,25	30	3,00	93,10
" " (Rhodn Hill)	61,6	65,5	...	69,5	57,6	135,3	55,8	73	5	55	1	64	1	60	1	1,6	2,2	...	16,7	18,1	...	90	88	...	15,19	385,9	36,0	22nd	29	3,12	96,80
Fraser's Hill	63,8	69,8	63,9	72,4	61,8	...	...	76	1	59	1	63	1	64	4	1,4	3,5	0,8	18,2	19,9	19,1	92	83	96	16,25	260,3	17,3	5th	25	3,66	113,10

RAINFALL STATIONS

Perak. —	Total.		Most in a day.	Date.	No. of rainfall days.	—	Total.		Most in a day.	Date.	No. of rainfall days.	Selangor. —	Total.		Most in a day.	Date.	No. of rainfall days.	Negri Sembilan. —	Total.		Most in a day.	Date.	No. of rainfall days.	Pahang. —	Total.		Most in a day.	Date.	No. of rainfall days.
	In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.		
Kuala Kuran	8,94	227,1	36,0	22nd	19	P. Tanjong	22,64	375	73,5	31st	23	Sabak Fernam	7,13	181,4	48,2	24th	15	Mantin	11,11	282,2	14,5	22nd	20	Tererlob	13,64	346,5	96,3	22nd	20
The Cottage	20,15	664,2	81,3	12th	28	Bagan Datoh	7,13	181	40,3	29th	20	Dist. Hospital K. L.	13,65	347,0	86,7	4th	18							K. Tembeling	8,45	211,6	38,1	15th	23
Maxwell's Hill	7,24	692,9	94,0	17th	27	Sungkai	17,66	444	76,0	22nd	17	Prisons, K. L.	19,55	496,5	90,4	4th	20							Rompin	11,66	296,2	65,8	13th	16

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, APRIL, 1925.

Station.	Air Temperature in degrees Fahrenheit. Means. 9 A.M.	3 P.M.	9 P.M.	Maximum.	Minimum.	Max. in Sun (black bulb in vacuo.)	Minimum on grass.	Absolute Extremes. Highest max.	No. of days.	Lowest min.	No. of days.	Lowest max.	No. of days.	Highest min.	No. of days.	Humidity. Means. Depression of Wet Bulb 9 A.M.	3 P.M.	9 P.M.	Vapour Pressure. 9 A.M.	3 P.M.	9 P.M.	Percentage. 9 A.M.	3 P.M.	9 P.M.	Rainfall. Total.		Most in a day. Amount.	Date.	No. of Rainfall days.	Bright Sunshine. Daily mean.	Total.
	°	°	°	°	°	°	°	°		°		°		°		°	°	°	m.b.	m.b.	m.b.	%	%	%	In.	m.m.	m.m.			Hrs.	Hrs.
PERAK—																															
Taiping	81,4	83,0	78,1	89,1	73,9	155,2	69,9	93	4	72	2	84	1	77	1	3,8	4,8	1,8	29,3	30.3	29.4	84	80	92	22,83	580,0	57,0	3rd	25	...	...
Kuala Kangsar	77,9	85,9	76,3	90,1	74,1	...	...	93	1	72	1	87	2	76	2	1,9	7,3	0,9	29.0	28,2	29.2	91	71	96	7.40	188 0	40,5	12th	16	...	...
Batu Gajah	80,1	85,7	77,4	90,0	73,3	154,8	...	93	2	72	6	82	1	75	4	3,4	5,9	1,6	28,8	30 3	29,1	85	76	93	11.79	299.4	49,2	25th	20	...	...
Gopeng	80,8	83,6	77,6	88,9	71,4	...	...	91	3	67	1	85	1	74	4	4,9	6,6	2,3	27,0	27,0	28,1	78	73	89	15,89	403 5	61 0	17th	24	...	...
Ipoh	81,2	83,7	75,7	90,2	73,1	...	..	95	1	70	1	84	1	75	3	4,0	5,9	0,3	28,9	28,3	29,5	83	75	99	11,41	289.9	57,8	12th	27	...	...
Kampar	78,9	84,4	75,2	88,7	73,5	...	...	92	1	71	1	85	1	75	7	2,8	6,5	1,0	28,6	28 0	27,9	87	74	95	22,33	567.2	121 6	16th	25	...	...
Teluk Auson	79,9	85,9	76,7	89,1	73,6	...	...	92	1	72	2	82	2	75	4	2,1	6,3	1,3	30,7	29,8	28,9	91	75	94	9,29	236,0	29,0	19th	22	...	...
Tapah	79,6	84,0	77,6	88,1	74,5	...	...	92	1	71	2	85	1	78	1	2,7	5,8	0,8	29,4	28,8	30,6	88	76	96	20,42	518,7	89,0	16th	27	...	...
Parit Buntar ...	82,4	85,7	77,7	90,1	73,0	...	...	92	5	71	2	86	1	75	3	4,2	6,1	1,5	29,7	29,9	29,5	82	76	93	7.89	200,5	34,0	28th	14	...	...
Bagan Serai	81,7	85,2	76,4	87,2	74,0	...	...	90	1	72	1	83	1	75	7	3,8	6,6	1,9	29,7	28,7	27,5	84	74	91	8,68	200,5	43,0	6th	14	...	...
Selama . ..	79,2	83,6	76,3	88,2	73,8	...	...	92	1	71	1	84	1	76	1	2,3	4,6	1,4	29,6	30,3	28,3	90	81	93	21 24	539,5	67,0	1st	23	...	...
Lenggong	78,3	86,0	76,3	88,9	73,9	...	...	91	3	71	1	86	2	78	3	2,2	8,0	1,5	28,9	27,2	28,1	90	68	93	6,40	162,5	36,5	25th	16	...	...
Tanjong Malim	82,0	84,3	74,9	89,2	72,8	...	...	93	1	70	1	83	1	78	1	4,4	4,6	1,0	28,9	31,1	27,6	81	81	95	20,79	528 0	60 0	21st	26	...	...
Grik	78,2	86,6	76,1	91,8	73,1	...	...	95	1	71	2	83	1	75	3	3,6	9,2	2,7	26,5	26,1	26,0	84	64	87	6,73	170,9	46,5	4th	24	...	...
Klian Intan	75,8	82,5	74,0	86,6	71,0	...	...	89	1	69	3	83	1	74	1	1,9	5,9	1,2	27,0	27,1	26,4	91	75	94	12,15	308,6	60,2	2nd	20	...	...
Kroh	77,4	81,9	70,3	87,1	70,9	...	...	93	2	69	1	82	3	73	5	3,1	5,4	1,0	26,6	27,3	23,6	86	77	95	16,61	421,8	82 5	1st	23	...	...
Tanjong Rambutan ...	...	...	...	...	...	...	...	...	...	...	..		...	...	...	...	...	...	...	...	...	...	...	...	6,32	160,6	30,0	29th	11	...	...
Sitiawan	80,8	84,5	75,9	89,2	72,8	...	...	93	1	71	2	87	2	76	1	3,1	5,5	0,9	29,9	29,7	28,8	87	77	96	5,99	151,9	52,0	6th	8	...	...
SELANGOR—																															
Lake Gardens, Kuala Lumpur	81,1	84,0	75,9	90,2	72,3	156,0	71,6	93	7	70	3	84	1	74	4	4,8	6,8	1,1	27,4	27,1	28,4	79	72	95	11,20	284,5	67 5	21st	26	4,88	146,45
General Hospital ..	81,3	84,1	76,2	89,1	73,1	151,6	71,5	92	5	71	2	85	2	75	4	5,0	6,7	1,4	27,3	27,4	28,2	78	72	93	10,78	273,7	59,8	21st	25	...	...
Klang	79,3	82,8	76,9	83,8	74,1	...	...	88	1	72	2	80	1	76	1	3,1	5,7	3,0	28,5	27,7	26,3	86	76	86	12,75	323 9	48,2	26th	19	...	...
Kajang .. .	...	...	...	89,5	73,2	...	...	92	4	72	9	86	1	75	2	...	...	...	...	..	...	..	...	..	8,76	222,5	82 6	30th	18	...	...
Kuala Selangor	...	...	...	89,1	...	...	...	91	2	...	...	86	1	...	...	...	...	...	...	..	...	..	...	..	8,78	223,0	63,9	14th	11	...	...
Serendah	...	...	...	88,5	69,8	...	...	93	1	65	3	84	2	75	2	...	...	...	...	...	..	...	...	..	16 63	422,3	66,7	3rd	25	...	...
Kuala Kubu ..	...	...	...	88,4	72,5	...	...	93	1	71	9	85	2	78	1	...	...	...	...	...	...	...	..	..	12,68	322,0	60,9	23rd	24	...	...
Telok Datoh	...	...	...	86,8	73,3	...	...	91	2	72	3	84	6	75	1	...	...	...	...	...	...	...	...	...	11,47	291,3	40,2	28th	19	...	...
NEGRI SEMBILAN—																															
Seremban	80,1	82,4	78,1	90,1	72,9	...	67,5	93	2	71	1	86	3	75	2	2,8	4,2	1,6	28,8	29,7	29,7	88	82	93	11,17	299,0	48,5	13th	25	...	...
Kuala Pilah	80,2	87,0	77,1	89,5	70,7	...	...	92	7	68	1	86	3	73	1	3,9	8,3	1,8	28,1	27,8	28,4	82	68	92	20,58	522,7	90,0	12th	21	...	...
Tampin	81,7	83,7	76,8	90,3	69,9	...	...	93	2	69	5	87	1	70	25	4,5	5,5	1,1	28,6	28,9	29,2	81	77	95	15,23	387,0	91,0	12th	23	...	...
Port Dickson	80,4	84,4	80,0	85,8	73,9	154,7	...	89	1	72	5	84	7	75	12	3,5	5,4	3,3	28,9	29 7	29,8	85	77	86	6,94	176,4	44,0	26th	10	...	...
Jelebu . ..	83,1	84,9	78,5	87,4	72,1	...	...	90	1	70	1	84	1	75	1	4,3	5,5	2,7	30,2	30,1	28,3	82	77	88	5,90	149,8	25,2	12th	11	...	...
PAHANG—																															
Kuala Lipis	79,2	88,0	77,1	89,7	72,0	...	...	93	2	70	4	84	1	74	6	3,4	10,0	2,3	27,9	26,1	27,6	84	62	89	12,19	309,6	63,8	18th	19	...	...
Raub	79,2	85,3	75,4	88,4	72,6	...	72,0	91	4	69	1	84	1	74	6	3,5	7,6	1,0	27,7	27,2	28,1	84	70	95	8,40	213 4	43,7	17th	21	...	...
Bentong	78,3	85,2	75,7	89,3	73,3	...	...	92	2	71	1	83	1	76	1	2,6	7,1	1,1	28,1	27,9	28,2	88	72	95	14,15	359,4	65,5	15th	22	...	...
Pekan	82,0	84,6	77 6	87,0	73,7	...	...	90	3	68	1	85	2	75	9	3,9	5,6	1,1	29,8	29 7	30,0	83	77	95	7,85	199,4	62 0	10th	18	...	...
Kuantan	81,8	85,6	76,8	88,4	73,5	...	...	91	1	71	1	85	2	75	7	4,0	7,1	2,0	29,4	28,3	27,8	83	72	91	3,78	96,0	22,3	10th	13	...	...
Sungei Lembing ...	...	...	..	89,6	72,1	...	..	93	3	70	2	83	4	78	2	...	...	...	...	...	...	...	...	...	13,60	345,5	81,0	13th	19	...	...
Camerons H'lands (Tanah Rata)	62,0	67,9	63,0	72,1	56,3	138,7	54,0	75	2	51	1	69	2	61	1	0,6	2,5	0,6	18 0	19,8	18,7	96	87	96	17,65	448,2	58,3	4th	27	3,49	104,70
" " (Rhodn. Hill)	63,3	66,0	...	71,3	59,0	139,1	57,4	74	5	57	1	67	1	60	12	1,8	1,9	...	17,5	19,2	...	90	90	...	17,50	444,5	59,3	19th	28	3,80	111,95
Fraser's Hill	65,6	70,3	65,1	73,2	62,5	...	...	78	2	60	3	66	1	65	2	1,4	3,0	0,4	19,6	20,9	20,5	93	86	97	12,47	316,8	36,8	28th	25	3,95	118,35

RAINFALL STATIONS

Perak. —	Total.		Most in a day.	Date.	No. of rainfall days.	Selangor. —	Total.		Most in a day.	Date.	No. of rainfall days.	Selangor. —	Total.		Most in a day.	Date.	No. of rainfall days.	Negri Sembilan. —	Total.		Most in a day.	Date.	No. of rainfall days.	Pahang. —	Total.		Most in a day.	Date.	No. of rainfall days.
	In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m..m				In.	m.m.	m.m.		
Kuala Kurau	12,57	319,4	96,0	6th	12	P. Tahjong	21,23	539,3	150,0	28th	23	Sabak Bernam	7.97	202,4	77,2	5th	12	Mantin	10,33	262,3	26,6	11th	21	Temerloh	12,48	316,2	96,0	19th	18
The Cottage	15.81	401,6	50,1	11th	27	Bagan Datoh	3,98	101,0	34,5	6th	9	Dist. Hospital, K.L.	13.28	337,2	71,2	18th	25							K. Tembeling	8,15	214,6	38,1	15th	23
Maxwell's Hill	17,90	454,7	97,5	28th	24	Sungkai	21,91	556,5	100,0	1st	19	Prisons, K.L.	17,42	442,4	95,4	21st	23							Rompin	9,36	237,7	143,3	10th	13

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, MAY, 1925.

Station.	Air Temperature in degrees Fahrenheit. Means. 9 A.M.	3 P.M.	9 P.M.	Maximum.	Minimum.	Max. in Sun (Black bulb in vacuo).	Minimum on grass.	Absolute Extremes. Highest max.	No. of days.	Lowest min.	No. of days.	Lowest max.	No. of days.	Highest min.	No. of days.	Humidity. Means. Depression of Wet Bulb. 9 A.M.	3 P.M.	9 P.M.	Vapour Pressure. 9 A.M.	3 P.M.	9 P.M.	Percentage. 9 A.M.	3 P.M.	9 P.M.	Rainfall. Total.		Most in a day. Amount.	Date.	No. of rainfall days.	Bright Sunshine. Daily mean.	Total.
	°	°	°	°	°	°	°	°		°		°		°		°	°	°	m.b.	m.b.	m.b.	%	%	%	In.	m.m.	m.m.			Hrs.	Hrs.
PERAK—																															
Taiping	83.3	85.9	80.3	90.2	73.9	155.0	70.7	93	1	71	1	83	1	77	2	5.0	6.8	2.7	29.3	28.0	30.1	79	73	88	6.61	168.0	44.0	2nd	15	...	..
Kuala Kangsar	79.6	87.1	77.3	90.5	74.5	...	...	93	5	71	1	79	1	77	1	2.3	6.7	1.2	30.0	31.5	29.6	90	73	94	6.91	175.5	57.0	14th	11	...	..
Batu Gajah	82.2	89.4	79.9	91.5	74.4	152.4	...	96	1	71	3	81	1	76	7	4.3	8.3	2.5	29.3	30.2	30.0	82	68	89	5.91	150.2	48.2	9th	10	...	.
Gopeng	82.2	87.7	79.4	90.9	71.8	...	...	94	1	70	8	87	1	74	2	5.9	9.9	3.0	26.8	28.1	28.7	75	62	86	10.08	256.0	79.0	9th	13	...	...
Ipoh	81.7	88.3	77.8	91.5	74.3	...	...	96	1	71	3	84	1	77	1	4.2	8.8	1.3	29.0	28.3	29.9	82	66	94	6.36	161.6	42.6	2nd	13	...	...
Kampar	80.8	86.8	78.5	91.1	72.8	...	...	92	14	71	13	87	1	79	1	4.1	8.7	3.3	28.3	27.0	24.5	83	65	85	13.48	342.3	99.7	7th	13	...	...
Telok Anson	80.7	87.6	79.7	90.3	74.0	...	...	93	4	71	1	86	1	76	4	2.9	7.7	1.6	30.3	29.3	31.4	88	70	93	3.43	87.1	35.2	3rd	9	...	...
Tapah	80.9	87.6	77.6	90.2	74.8	...	...	93	3	71	1	83	1	77	4	3.8	8.7	1.1	28.9	27.7	30.0	84	67	95	13.20	335.3	120.5	4th	16	...	.
Parit Buntar	82.8	87.8	79.0	91.2	72.9	...	...	93	1	71	3	89	4	76	1	4.4	7.6	1.5	29.8	29.6	30.8	85	71	93	6.79	172.5	57.0	5th	11	...	...
Bagan Serai	81.6	86.5	76.5	88.0	74.0	...	...	90	3	72	6	86	5	76	3	3.6	8.6	2.9	29.9	29.9	26.1	85	67	86	4.43	115.0	31.0	31st	8	...	.
Selama	80.6	86.0	77.7	88.7	73.6	...	...	91	3	71	5	84	1	77	1	2.9	5.9	1.8	30.0	30.6	29.0	87	76	92	12.32	313.0	62.0	27th	16	...	...
Lenggong	79.3	84.5	77.8	89.3	74.3	...	...	92	2	72	4	87	4	78	1	2.6	5.5	2.4	29.2	29.7	28.1	89	77	89	7.36	187.0	34.0	14 31	12	...	...
Tanjong Malim	81.9	88.1	75.6	90.6	73.5	...	...	93	4	69	1	86	1	78	1	4.2	6.3	1.2	27.3	32.2	27.9	82	75	94	10.83	275.0	66.5	7th	14	...	...
Grik	79.1	85.5	76.1	91.3	73.7	...	...	95	1	70	1	88	3	76	1	3.4	7.9	2.7	28.6	27.0	26.0	84	68	87	8.42	213.9	47.5	5th	24	...	...
Klian Intan	76.7	84.1	75.2	87.0	72.7	...	...	90	1	69	3	8[illegible]	1	76	1	2.0	6.7	1.6	27.7	27.4	26.9	91	72	92	6.74	171.2	44.6	7th	11	...	...
Kroh	78.8	83.3	70.7	86.8	71.6	...	...	91	3	69	3	82	1	75	2	3.5	6.7	1.2	27.3	26.6	23.6	84	72	94	7.43	188.6	36.0	5th	13	...	...
Tanjong Rambutan ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4.50	114.4	28.6	4th	7	...	..
Sitiawan	80.7	85.4	77.1	90.5	73.3	...	...	94	1	71	3	87	1	75	6	3.0	5.8	1.0	30.0	30.1	29.7	87	77	95	4.05	102.0	54.5	5th	2	...	...
SELANGOR—																															
Lake Gardens, Kuala Lumpur	81.9	86.3	77.6	90.6	72.3	154.0	72.0	94	1	68	1	85	1	76	1	5.2	8.9	1.6	27.6	26.1	29.2	78	66	92	5.17	131.2	41.1	7th	13	6.94	215.10
General Hospital ...	82.3	86.4	78.1	90.2	73.2	151.1	72.2	94	1	70	1	85	1	75	6	5.9	8.7	2.1	26.9	26.5	28.9	76	67	90	5.46	138.8	31.4	7th	15	...	...
Klang	80.3	85.6	79.5	86.6	75.8	...	...	92	1	73	1	82	1	78	3	2.8	7.1	2.5	29.9	28.3	29.6	88	72	89	3.08	78.3	63.0	20th	9	...	...
Kajang	...	...	...	90.8	72.7	...	...	93	3	71	4	87	1	74	8	...	...		...	..	..		...	..	7.98	202.8	136.8	7th	9	...	...
Kuala Selangor ..	...	...	...	90.9	...	...	...	95	1	...	..	86	1	...	..	...	..	...	...	...		..	..	...	5.55	141.0	51.7	20th	7	...	..
Serendah . ..	...	...	...	90.0	71.6	...	...	91	1	69	3	87	2	74	2	...	...	...		...			..		8.27	210.0	64.0	1st	14	...	...
Kuala Kubu	...	...	...	90.0	...	...	...	93	4	...	..	86	3	...	..	...	...	...	..	...	...	..	...	..	7.81	198.5	43.4	5th	13	...	...
Telok Datoh	...	...	...	88.3	73.9	...	...	91	1	73	8	84	2	75	7	...	...	...	...	...	...	...	...	...	3.09	78.6	18.6	8th	11	...	...
NEGRI SEMBILAN—																															...
Seremban	82.1	85.6	78.9	90.8	73.0	...	67.6	93	2	71	1	88	2	75	2	4.2	6.8	2.1	29.4	28.5	29.7	82	73	91	4.17	106.0	20.0	5th	13	...	.
Kuala Pilah	82.1	87.5	78.0	90.7	71.2	...	...	94	1	68	1	88	1	73	4	4.7	8.0	1.7	28.9	28.8	29.4	77	65	91	6.80	172.8	57.6	4th	12	...	...
Tampin	81.9	87.8	77.4	92.3	70.3	.	...	98	1	70	23	90	2	72	1	5.6	9.3	1.6	29.0	27.0	29.0	77	61	93	4.45	113.0	37.4	4th	9	...	...
Port Dickson	81.9	85.6	81.3	86.8	75.2	156.4	...	90	1	74	4	84	1	77	1	4.2	6.2	3.6	28.1	29.7	29.6	79	71	83	2.18	55.4	20.4	23rd	5	...	...
Jelebu	84.0	85.7	78.5	88.3	72.2	...	...	90	5	70	1	86	2	74	2	5.0	5.9	2.7	30.0	30.4	28.3	74	71	84	3.17	80.4	31.2	5th	4	...	...
PAHANG—																															
Kuala Lipis	79.2	88.9	77.9	90.4	72.1	...	...	94	1	69	3	84	1	75	3	2.7	6.2	1.8	28.9	33.3	29.2	88	76	92	8.24	209.3	36.8	18th	13	...	...
Raub	80.1	86.7	76.6	89.8	72.6	...	...	9	4	69	1	88	4	76	1	3.1	7.5	1.1	29.2	28.8	29.0	86	70	95	5.11	129.8	36.1	8th	13	...	...
Bentong	78.1	87.8	76.7	91.0	73.8	...	...	93	6	70	1	89	1	77	2	3.9	9.0	1.5	26.1	27.4	28.6	82	66	93	6.42	163.1	41.7	28th	12	...	...
Pekan	82.8	87.1	78.3	89.5	74.0	...	...	93	2	71	1	88	7	76	2	2.8	6.9	1.4	30.8	30.1	30.2	84	72	93	3.09	78.5	18.0	27th	11	...	...
Kuantan	82.7	87.6	78.5	90.2	73.0	...	...	97	1	71	1	87	1	76	3	3.3	7.1	2.2	31.6	30.3	29.1	86	72	90	5.51	140.0	69.1	29th	9	...	...
Sungei Lembing ...	...	...	...	...	...	...	...	...	...	...	..	...	..	...	..	...	...	...	...	...	...	...	...	...	11.39	289.3	50.8	1st	17	...	...
Camerons H'lands (Tanah Rata)	63.1	70.6	63.9	73.5	56.8	...	53.9	77	1	51	1	69	1	62	1	1.0	4.5	0.7	18.2	20.0	19.3	95	79	96	10.45	265.4	32.3	26th	19	4.98	154.35
" " (Rhodn Hill)	63.5	68.7	...	72.5	60.0	140.1	56.0	76	2	58	2	68	2	61	12	1.6	3.8	...	17.8	18.0	...	91	82	...	8.41	213.7	28.8	26th	19	5.25	162.70
Fraser's Hill	66.9	71.7	65.8	75.3	62.7	142.1	...	77	7	59	1	73	3	65	2	2.0	4.2	0.9	19.5	21.2	20.3	90	81	95	3.37	85.6	19.6	5th	16	5.88	182.20

RAINFALL STATIONS.

Perak. —	Total.		Most in a day.	Date.	No. of rainfall days.	—	Total.		Most in a day.	Date.	No. of rainfall days.
	Inc.	m.m.	m.m.				In.	m.m.	m.m.		
Kuala Kurau	7.10	180.4	56.8	9th	11	P. Tanjong	11.32	287.5	105.0	14th	16
The Cottage	22.13	562.1	119.6	18th	21	Bagan Datoh	2.15	54.7	11.8	10th	12
Maxwell's Hill	12.26	311.4	74.9	5th	21	Sungkai	6.32	160.5	42.0	4th	10

Selangor. —	Total.		Most in a day.	Date.	No. of rainfall days.
	In.	m.m.	m.m.		
Sabak Fernam	1.32	33.5	7.4	1st	10
Dist. Hospital K. L.	8.08	205.2	39.8	1st	15
Prisons, K. L.	7.35	186.8	88.4	20th	15

Negri Sembilan. —	Total.		Most in a day.	Date.	No. of rainfall days.
	In.	m.m.	m.m.		
Mantin	5.13	130.3	43.5	4th	8

Pahang. —	Total.		Most in a day.	Date.	No. of rainfall days.
	In.	m.m.	m.m.		
Temerloh	4.48	113.8	24.9	2nd	14
K. Tembeling	0.99	25.1	9.1	8th	7
Rompin	5.61	142.5	27.2	22nd	16

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, JUNE, 1925.

Station.	Air Temperature in degrees Fahrenheit. Means. 9 A.M.	3 P.M.	9 P.M.	Maximum.	Minimum.	Max. in Sun (Black bulb in vacuo).	Minimum on grass.	Absolute Extremes. Highest max.	No. of days.	Lowest min.	No. of days.	Lowest max.	No. of days.	Highest min.	No. of days.	Humidity. Means. Depression of Wet Bulb. 9 A.M.	3 P.M.	9 P.M.	Vapour Pressure. 9 A.M.	3 P.M.	9 P.M.	Percentage. 9 A.M.	3 P.M.	9 P.M.	Rainfall. Total.		Most in a day. Amount.	Date.	No. of rainfall days.	Bright Sunshine. Daily mean.	Total.
	°	°	°	°	°	°	°	°		°		°		°					m.b.	m.b.	m.b.	%	%	%	In.	m.m.	m.m.			Hrs.	Hrs.
PERAK—																															
Taiping	82,2	85,7	79,3	89,0	73,4	150,9	69,2	92	3	72	5	83	2	76	1	5,1	6,8	2,8	28,1	28,9	28,9	79	73	87	10,83	275,0	66,5	16th	14	...	...
Kuala Kangsar	78,7	86,0	77,1	89,6	73,4	...	...	93	2	71	3	78	1	76	1	2,4	5,9	0,9	28,9	30,5	28,9	89	76	96	2,86	72,7	21,5	21st	8	...	...
Batu Gajah	81,3	88,0	79,6	90,5	73,3	151,3	...	94	1	70	1	81	2	76	1	4,3	8,2	2,5	28,5	28,9	29,7	82	68	89	5,36	136,1	49,4	17th	7	...	...
Gopeng	81,3	87,0	78,3	90,5	72,2	...	...	93	1	70	4	86	1	76	1	6,0	9,9	2,9	25,8	25,4	27,8	74	62	86	4,80	122,0	25,5	18th	13	...	...
Ipoh	80,9	87,4	77,0	90,0	72,9	...	...	95	2	68	1	81	1	76	1	4,0	8,9	0,3	28,6	28,2	30,8	83	65	99	4,31	109,4	38,2	17th	16	...	...
Kampar	79,7	86,4	77,6	90,6	72,2	...	...	94	1	70	4	83	1	79	1	3,7	9,2	2,4	27,9	25,7	27,9	83	64	89	10,66	270,9	82,4	12th	12	...	...
Telok Anson	80,5	86,7	78,4	89,5	73,0	...	...	92	2	71	3	81	1	75	2	3,2	7,4	1,3	27,5	28,9	30,5	86	70	94	3,82	97,1	22,2	17th	11	...	...
Tapah	80,7	86,5	76,7	89,9	73,5	...	...	94	2	69	2	81	1	79	1	4,3	7,8	1,6	27,9	28,1	28,4	81	69	93	8,55	217,2	54,5	3rd	17	...	...
Parit Buntar	82,9	87,9	78,9	89,8	73,6	...	...	92	5	72	4	86	2	75	3	4,0	6,7	1,7	30,5	31,2	30,3	83	74	92	8,82	224,0	84,0	20th	8	...	...
Bagan Serai	81,1	85,5	76,3	88,0	73,7	...	...	91	1	72	4	84	1	77	1	3,7	8,2	2,5	29,2	26,5	26,5	84	67	88	11,73	298,0	120,5	20th	9	...	...
Selama	79,6	86,7	77,6	88,0	73,3	...	...	91	3	71	1	78	1	76	1	2,8	6,8	1,8	29,2	29,8	28,9	88	73	92	9,59	243,5	66,5	21st	12	...	...
Lenggong	77,5	85,0	76,9	87,6	72,8	...	...	92	2	69	1	85	1	77	1	2,4	6,7	1,5	27,8	28,3	28,8	89	73	93	4,45	113,0	32,0	3rd	9	...	...
Tanjong Malim	80,2	85,4	75,0	90,0	71,5	...	...	94	1	68	1	84	2	75	1	3,6	6,9	0,9	28,5	28,4	27,9	85	72	96	13,76	349,5	78,0	3rd	15	...	...
Grik	78,5	85,4	76,0	90,2	73,0	...	...	93	1	69	1	87	2	75	4	3,5	10,8	2,7	27,0	22,7	25,0	84	58	87	4,61	117,1	32,0	17th	14	...	...
Klian Intan	76,3	82,2	74,8	85,0	70,4	...	...	89	1	67	3	75	1	74	1	2,2	5,1	1,8	27,0	28,1	26,2	89	79	91	8,13	206,4	62,0	1st	13	...	...
Kroh	78,2	82,6	70,3	85,6	70,5	...	...	90	1	67	1	80	1	73	2	3,4	6,5	1,1	26,1	26,2	23,4	84	73	94	8,39	213,2	55,0	21st	15	...	...
Tanjong Rambutan ...	...	...	...	...	...	...	...	94	2	70	2	87	1	79	3	...	...	...	...	...	...	...	...	...	5,22	132,5	18,9	20th	9	...	.
Sitiawan	82,0	86,2	76,9	89,6	73,0	...	...	93	3	71	3	81	1	75	3	4,3	6,9	1,0	29,1	29,3	29,5	82	73	95	2,63	66,8	20,5	20th	9	...	...
SELANGOR—																															
Lake Gardens, Kuala Lumpur	80,9	84,0	76,5	89,8	71,5	153,6	70,8	93	3	69	2	83	1	74	1	4,8	7,0	1,5	27,2	26,9	28,3	79	72	93	7,76	197,2	43,1	8th	15	5,63	169,05
General Hospital ...	80,8	84,6	77,1	89,3	72,6	147,5	70,7	93	1	70	2	83	1	75	1	5,1	7,3	2,0	26,7	27,0	28,1	78	71	91	8,70	221,1	48,5	4th	15	...	...
Klang	80,0	85,1	78,2	86,1	74,5	...	...	90	1	73	6	80	1	78	1	3,6	6,6	1,7	28,4	28,6	29,6	84	74	92	3,23	81,7	56,4	12th	10	...	...
Kajang	...	...	...	89,1	72,0	...	...	92	1	70	2	87	2	74	1	...	...	...	...	...	...	...	...	...	10,51	267,0	81,0	12th	14	...	...
Kuala Selangor ...	...	...	...	90,5	...	...	...	94	2	...	...	83	1	...	...	...	...	...	...	...	...	...	...	...	1,91	48,6	19,1	16th	5	...	...
Serendah	81,0	85,8	75,1	89,5	71,0	...	...	94	1	69	1	84	1	73	3	5,4	8,5	1,6	26,4	26,3	27,0	77	66	92	7,02	178,3	37,0	9th	16	...	...
Kuala Kubu	80,3	84,5	75,1	89,6	71,1	...	...	93	3	68	1	83	1	75	2	5,0	7,2	1,1	27,0	28,2	27,6	78	71	95	11,0	279,5	86,7	7th	15	...	...
Telok Datoh	...	...	...	87,5	73,3	...	...	91	2	72	5	83	1	76	1	...	...	...	...	...	...	...	...	...	6,21	157,8	57,8	13th	8	...	...
NEGRI SEMBILAN—																															...
Seremban	81,2	85,0	78,3	90,2	72,8	...	67,6	93	2	71	2	86	1	75	1	4,0	6,6	1,4	28,9	28,5	30,2	83	74	93	3,82	97,1	18,7	13th	16	...	..
Kuala Pilah	80,7	87,6	78,0	90,2	70,1	...	...	92	8	67	1	87	2	73	1	3,7	7,5	2,1	28,9	28,8	28,9	82	66	90	2,87	72,9	34,0	18th	9	...	...
Tampin	82,7	87,3	78,0	91,2	70,4	...	...	93	2	70	22	88	2	72	3	4,4	8,1	2,1	29,7	28,4	28,9	81	69	91	10,51	267,0	54,2	4th	14	...	..
Port Dickson	80,7	84,5	80,2	86,1	74,4	149,0	...	88	7	72	1	84	4	76	5	3,6	5,6	3,4	28,4	29,5	28,9	83	73	84	10,94	278,0	118,0	17th	11	...	...
Jelebu	82,6	85,2	78,5	87,8	71,9	...	...	90	4	69	1	85	1	74	3	4,0	4,8	1,8	30,2	31,7	29,8	78	75	90	6,12	155,4	35,2	9th	13	...	...
PAHANG—																															
Kuala Lipis	78,3	87,5	78,0	89,9	72,4	...	...	92	3	70	1	83	1	75	1	2,7	8,7	2,0	28,1	27,6	28,9	87	67	91	8,02	203,7	61,0	20th	13	...	...
Raub	79,3	85,7	76,2	88,4	71,6	..	70,4	92	2	69	2	83	1	80	1	3,6	7,2	1,0	27,6	28,2	28,9	84	71	95	5,21	132,3	30,5	18th	13	...	...
Bentong	78,1	84,9	76,5	89,9	72,9	...	...	93	2	71	4	86	1	75	3	3,5	7,2	1,1	26,7	27,4	28,9	84	71	95	4,72	119,9	38,1	9th	11	...	...
Pekan	83,5	86,9	77,7	88,5	73,7	...	...	92	2	72	1	86	1	76	1	4,6	5,7	1,6	30,1	32,0	29,3	81	77	93	8,18	207,8	70,1	20th	11	...	...
Kuantan	82,3	86,3	77,4	88,7	73,7	...	...	92	1	72	8	83	1	79	1	4,7	6,5	1,4	28,8	29,9	29,3	80	74	93	10,06	255,5	81,3	22nd	15	...	..
Sungei Lembing ...	...	...	...	91,2	72,2	...	...	94	1	71	4	85	1	74	1	...	...	...	...	...	...	...	...	...	19,12	485,7	81,8	16th	17	...	...
Camerons H'lands (Tanah Rata)	61,7	69,3	62,0	71,4	55,0	133,7	52,3	76	1	49	1	64	2	62	1	1,0	4,4	0,9	17,4	18,4	17,7	94	79	95	9,81	249,1	86,9	16th	18	4,92	147,50
,, ,, (Rhodn Hill)	62,8	67,6	...	70,4	58,7	136,9	56,9	75	1	56	1	61	1	60	6	2,3	3,9	...	16,6	17,9	...	88	81	...	8,35	212,0	72,1	16th	17	5,32	159,65
Fraser's Hill	66,3	70,8	65,0	73,6	61,4	...	...	77	1	57	1	70	2	64	1	2,2	4,2	1,6	19,0	19,8	18,9	89	80	91	2,21	56,1	9,9	4th	17	5,08	152,40

RAINFALL STATIONS.

Perak. —	Total.		Most in a day.	Date.	No. of rainfall days.	—	Total.		Most in a day.	Date.	No. of rainfall days.	Selangor. —	Total.		Most in a day.	Date.	No. of rainfall days.	Negri Sembilan. —	Total.		Most in a day.	Date.	No. of rainfall days.	Pahang. —	Total.		Most in a day.	Date.	No. of rainfall days.
	In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.		
Kuala Kuran	16,86	428,2	190,7	20th	8	P. Tanjong	4.57	116,1	21,0	10th	16	Sabak Fernam	4,05	103,0	44,2	15th	10	Mantin	3,74	95,1	46,1	13th	7	Terrerloh	5,43	137,9	20,1	15th	17
The Cottage	:8,06	712,7	115,8	16th	17	Bagan Datoh	4,24	107,[illegible]	17,4	21st	12	Dist. Hospital K. L.	7,15	181,6	34,4	4th	14							K. Tembeling	4,89	124,2	68,3	20th	12
Maxwell's Hil	0,55	522,0	86,4	3rd	16	Sungkai	8,94	227,[illegible]	104,0	17th	8	Prisons, K. L.	7,79	197,8	38,1	15th	15							Rompin	7,05	179,1	55,4	2nd	15

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, JULY, 1925.

Station.	Air Temperature in degrees Fahrenheit. Means. 9 A.M.	3 P.M.	9 P.M.	Maximum.	Minimum.	Max. in Sun (black bulb in vacuo.)	Minimum on grass.	Absolute Extremes. Highest max.	No. of days.	Lowest min.	No. of days.	Lowest max.	No. of days.	Highest min.	No. of days.	Humidity. Means. Depression of Wet Bulb 9 A.M.	3 P.M.	9 P.M.	Vapour Pressure. 9 A.M.	3 P.M.	9 P.M.	Percentage. 9 A.M.	3 P.M.	9 P.M.	Rainfall. Total.		Most in a day. Amount.	Date.	No. of Rainfall days	Bright Sunshine. Daily mean.	Total.
PERAK—	°	°	°	°	°	°	°	°		°		°		°		°	°	°	m.b.	m.b.	m.b.	%	%	%	In.	m.m.	m.m.			Hrs.	Hrs.
Taiping	81,9	86,8	79,7	91,2	72,7	151,9	68,7	93	5	70	4	88	1	80	1	5,1	8,4	3,3	27,8	27,4	28,6	79	67	85	6,81	173,0	76,0	21st	9	...	...
Kuala Kangsar	77,6	86,8	76,9	90,2	72,7	...	...	93	1	71	3	86	2	75	1	2,3	8,2	1,2	28,1	27,6	29,2	89	68	94	4,02	102 0	25,5	18th	11	...	...
Batu Gajah	80,4	88,8	79,1	91,7	72,4	152,7	...	95	1	69	1	89	1	75	2	4,4	9,3	3,9	27,4	28 0	27,0	80	65	82	3,85	97,8	27,1	31st	11	...	...
Gopeng	80,6	88,0	78,2	91,1	71,7	...	...	95	1	69	1	87	1	75	1	5,9	11,2	3,3	25,4	24,5	27,0	74	58	85	4,69	119,0	50,0	31st	14	...	...
Ipoh	80,4	87,8	76,5	92,4	72,1	...	..	95	2	69	1	89	2	75	1	4,3	10,0	0,9	27,6	26,0	29,3	81	62	96	2,67	67,7	13,3	31st	14	...	...
Kampar	79,4	86,5	76,9	90,5	71,6	...	...	93	2	67	1	88	2	76	2	4,7	10,3	2,2	26,1	24 5	27,6	79	60	90	6,54	166,2	51 6	22nd	9	...	...
Teluk Anson	79,9	86,4	77,8	89,5	72,5	...	...	93	1	69	1	86	1	75	1	3,2	8,0	1,6	28,9	27,6	29,4	86	68	93	3,09	78,5	20,2	20th	10	...	...
Tapah	80,5	87,2	74,7	90,7	71,5	...	...	94	1	67	4	88	1	75	4	5,2	8,4	1,4	26,3	27,8	26,8	77	67	93	6,94	176,3	50,5	22nd	15	...	...
Parit Buntar ..	82,6	88,3	78,7	90,5	72,7	...	...	92	5	70	3	88	3	75	3	4,9	9,2	1,9	28,8	27,6	29,8	79	65	91	2 79	71,0	22,4	24th	5	...	...
Bagan Serai	82,3	86,9	77,4	88,7	73,9	...	...	90	5	70	1	87	1	78	1	5,6	9,5	2,7	27,4	25,9	27,2	77	63	87	4,61	117,0	44,0	5th	6	...	...
Selama . .	79,2	86,4	77,2	88,7	71,9	...	...	91	1	70	5	84	1	75	1	3,1	7,1	1,7	28,4	29,0	28,7	86	72	92	4,21	107,0	40,5	21st	10	...	...
Lenggong	76,6	85,5	75,8	88,0	71,7	...	...	91	1	69	1	84	2	74	2	2,1	9,2	1,4	27,4	25,0	27,8	90	65	93	1,59	40,5	12,5	26th	6	...	...
Tanjong Malim . ..	79,6	87,5	73,9	90,4	70,7	...	...	93	4	67	1	88	2	75	2	3,9	8,3	1,0	27,5	28 3	26,7	82	68	95	1,97	50 0	11 5	28th	9	...	...
Grik	78,6	88,5	75,9	90 8	72,7	...	...	93	2	70	3	87	1	75	3	3,3	10,3	2,3	27,4	26,3	26,5	85	61	89	4,94	125 5	39,0	20th	14	...	...
Klian Intan	74,7	83,2	74,1	85,6	69,5	...	...	88	3	68	8	82	2	72	4	1,8	6,2	1,9	26,1	27,3	25 4	91	74	90	4,20	106,6	18,4	18th	17	...	...
Kroh	77,2	34,4	70,5	85,7	70,0	...	...	93	1	68	1	81	4	74	1	3,3	8,3	1,0	26,1	25 3	23,7	85	67	95	2,08	52,8	11,9	23rd	11	...	...
Tanjong Rambutan ..	...	...	...	90,8	72,9	...	...	93	11	69	1	82	1	80	2	...	...	...	...	...	...	...	...	...	4,09	103 9	20,9	17th	9	...	...
Sitiawan .. .	82,0	87,7	76,8	91,0	71,9	...	...	94	1	68	1	85	1	75	1	5,5	8,2	1,3	27,2	28 7	28,9	77	68	94	5,02	76,6	29,1	21th	7	...	...
SELANGOR—																															
Lake Gardens, Kuala Lumpur	79,6	85,0	75,9	89,5	69,9	150,8	69,6	92	5	67	2	86	1	72	4	4,3	9,0	1,7	26,9	24,8	27,4	81	65	92	2,16	55 0	15 6	25th	14	6,37	197,40
General Hospital ..	80,3	85,5	77,1	89,6	71,8	146,7	69,5	92	2	69	2	85	1	74	3	5,1	9,0	2,5	26,2	25,2	27,2	78	64	88	2,57	65,2	17,3	15th	14	...	...
Klang	79,1	85,9	78,1	85,8	73,9	...	...	90	1	71	1	82	2	76	2	3,3	8,6	2,7	27,9	26 2	27,9	85	66	87	4,72	120 0	39,9	26th	8	...	...
Kajang	78,3	87,0	75,3	88,4	72,1	...	...	91	3	69	1	85	1	74	2	3,8	9,5	2,3	26,4	26,0	25,9	83	64	89	4,03	102,4	16 3	27th	16	...	...
Kuala Selangor	...	...	...	90,7	...	...	...	93	2	...	...	89	4	...	...	...	...	...	...	...	...	..	..	...	2,72	69 1	47,3	19th	9	...	...
Serendah	81,5	83,6	76,1	90,3	70,3	...	...	92	6	67	1	88	1	73	2	5,5	9 7	2,1	26,8	25,4	27,0	77	63	90	4,94	125,5	67,3	20th	9	...	...
Kuala Kubu	80,2	85,7	75,1	90,2	70,0	...	...	94	1	67	4	83	1	75	1	5,1	8,9	2,1	26,1	26,6	26,1	78	65	90	3,66	93,0	16,3	16th	12	...	...
Telok Datoh	...	...	...	87,3	72,5	...	...	90	1	70	2	85	4	75	1	...	...	...	...	...	...	...	..	..	6,07	154,1	25,2	10th	15	...	...
NEGRI SEMBILAN—																															
Seremban	80,2	81,1	78,4	90,9	72,1	...	67,3	93	4	70	2	89	5	74	1	2,9	5,5	1,7	29,6	29,3	29,8	87	77	92	5,74	145,7	28,6	31st	16	...	...
Kuala Pilah	79,9	85 7	77,2	89,4	69,3	...	...	92	4	67	1	85	1	72	1	4,2	9 2	2,5	26,3	26 1	27,3	81	65	88	4,06	103 1	42,4	5th	14	...	...
Tampin	82,2	87,1	78,1	90,3	70,0	...	...	92	1	68	1	87	1	71	3	4,4	6,4	1,9	29,2	31,0	29,2	81	74	91	5,15	130 8	27,6	30th	13	...	...
Port Dickson	80,5	85,0	80,0	86,1	74,4	150,8	...	89	1	72	1	84	6	77	1	3,7	5,9	3,3	28,7	29 6	28 9	84	76	86	9,02	229,0	126 0	31 t	14	...	...
Jelebu . ..	82,0	84,4	78,4	87,1	70,6	...	...	91	1	69	3	85	2	73	2	3,9	4,0	1,7	29,8	30,2	29,8	83	83	92	3,16	88 0	33 5	27th	7	...	...
PAHANG—																															
Kuala Lipis	76,8	86,1	77,0	90,1	70,7	...	...	93	3	68	3	87	3	75	1	3,4	7,3	2,0	25 6	28,5	28,0	84	71	91	3,29	83 6	45,2	19 h	6	...	...
Raub ..	78,3	85,7	74,9	88,9	69,8	...	68,0	92	1	67	2	85	1	72	1	4,0	8 4	1,3	26,1	26,3	27 [illegible]	82	66	94	3,22	81 8	30,4	[illegible]9th	15	...	...
Bentong	77,0	84 9	75,7	90,1	71,5	...	...	92	7	68	1	87	1	76	1	4,7	7,3	1,2	26 9	27,3	28,0	87	71	94	4,07	103,4	41,5	16th	13	...	...
Pekan	...	...	...	89,4	75,0	...	...	92	5	73	3	86	1	77	2	...	...	...	...	...	...	...	..	..	1,83	46 5	11 5	8th	7	...	...
Kuantan ...	81,4	86,8	76,8	88,8	73,1	...	...	91	5	69	1	86	1	75	8	4,3	7,8	2,0	28 6	28,4	27,8	82	69	91	4,8[illegible]	24,2	31,3	19th	13	...	...
Sungei Lembing ..	..	...	..	91,4	71,7	...	..	94	2	68	1	85	1	75	1	...	...	...	..	..	...	..	...	...	6,10	154,9	71,9	27th	2	...	...
Camerons H'lands (Tanah Rata)	60,8	69,3	61,8	71 7	53,4	140,4	51,3	75	2	47	1	68	1	60	1	0,9	5,2	0,9	17 0	17 5	17 6	95	75	95	3,47	88,1	20 5	22nd	16	4,98	154,45
" , (Rhodn. Hill)	61,7	67,7	...	70,4	58,0	138,1	55,8	74	4	46	2	67	1	60	2	1,8	1,5	...	16,2	17,3	..	90	78	...	3,65	92,6	24 4	22nd	15	5,10	158,25
Fraser's Hill	65,4	70,4	64,8	73,4	61,0	141,3	58,8	77	1	58	2	69	1	63	8	2,0	5,0	1,8	18,7	18,8	18 4	89	77	90	5,03	127,8	79,0	19th	13	5,45	168,90

RAINFALL STATIONS.

Perak. —	Total. In.	m.m.	Most in a day. m.m.	Date.	No. of rainfall days.
Kuala Kurau	6,22	158,1	76,2	24th	5
The Cottage	13,04	331,2	91,7	26th	13
Maxwell's Hill	8,56	217,4	51,3	26th	13
P. Tanjong	3,92	99,5	35,0	6th	8
Bagan Datoh	2,03	51,7	16,0	28th	5
Sungkai	9,61	244,0	54,0	27th	9

Selangor. —	Total. In.	m.m.	Most in a day. m.m.	Date.	No. of rainfall days.
Sabak Pernam	0,67	16,9	7,6	31st	3
Dist. Hospital, K.L.	3,79	96,4	16,8	20th	16
Prisons, K.L.	3,3	83,8	19,6	10th	17

Negri Sembilan. —	Total. In.	m.m.	Most in a day. m.m.	Date.	No. of rainfall days.
Mantin	4,49	114,1	30,7	26th	11

Pahang. —	Total. In.	m.m.	Most in a day. m.m.	Date.	No. of rainfall days.
Temerloh	3,64	92,4	18,3	11th	10
K. Tembeling	0,51	12,9	5,4	7th	5
Rompin	7,09	180,1	30,5	5th	13

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, AUGUST, 1925.

Station.	Air Temperature in degrees Fahrenheit. Means. 9 A.M.	3 P.M.	9 P.M.	Maximum.	Minimum.	Max. in Sun (Black bulb in vacuo).	Minimum on grass.	Absolute Extremes. Highest max.	No. of days.	Lowest min.	No. of days.	Lowest max.	No. of days.	Highest min.	No. of days.	Humidity. Means. Depression of Wet Bulb. 9 A.M.	3 P.M.	9 P.M.	Vapour Pressure. 9 A.M.	3 P.M.	9 P.M.	Percentage. 9 A.M.	3 P.M.	9 P.M.	Rainfall. Total.		Most in a day. Amount.	Date.	No. of rainfall days.	Bright Sunshine. Daily mean.	Total.
	°	°	°	°	°	°	°	°		°		°		°					m.b.	m.b.	m.b.	%	%	%	In.	m.m.	m.m.			Hrs.	Hrs.
PERAK—																															
Taiping	81.5	85.7	79.7	89.9	73.2	151.5	69.8	93	1	70	1	84	1	76	1	4.6	7.7	2.9	28.2	27.4	29.1	81	69	87	5.79	147.0	70.0	2nd	15	...	...
Kuala Kangsar	77.5	86.9	77.0	89.8	72.8	...	...	94	2	70	1	84	1	75	3	2.2	8.4	1.6	28.2	27.5	28.7	90	67	93	4.89	124.3	42.5	26th	13	...	..
Batu Gajah	79.7	88.5	79.6	90.9	72.6	151.9	...	94	1	70	1	85	1	75	1	3.9	8.7	2.6	27.6	28.7	29.5	82	67	89	6.92	175.8	71.5	15th	12	...	
Gopeng	80.0	88.4	78.1	90.5	72.3	...	...	94	1	69	1	85	1	75	3	5.1	11.6	3.1	26.0	24.3	27.3	78	57	86	6.41	162.8	40.0	16th	14	...	..
Ipoh	79.5	85.9	77.2	90.8	72.3	...	...	96	1	70	2	86	1	75	1	3.7	8.4	1.2	27.6	26.5	29.3	83	66	94	7.59	192.8	45.8	2nd	16	...	.
Kampar	79.4	87.7	77.4	90.2	72.0	...	...	93	1	69	3	85	1	76	2	4.8	11.4	2.8	25.9	24.0	27.0	79	57	87	3.00	76.2	19.4	2nd	14	...	...
Teluk Anson	79.6	87.1	78.6	89.3	73.0	...	...	94	1	70	3	83	1	76	1	2.8	8.3	1.9	29.2	27.9	29.7	88	68	91	4.18	106.2	33.0	17th	8	...	...
Tapah	79.7	88.1	75.8	90.7	71.7	...	...	95	1	67	1	84	1	77	2	5.0	9.5	1.5	25.9	27.0	27.6	78	64	93	6.15	156.1	58.5	2nd	16	...	...
Parit Buntar	81.2	87.5	78.8	90.3	73.2	...	...	92	10	71	3	85	1	75	7	3.7	7.4	1.9	29.3	29.7	29.9	84	71	91	5.53	140.6	65.2	18th	11	...	...
Bagan Serai	80.7	83.4	76.8	87.6	73.7	...	...	90	3	70	2	82	1	78	1	4.2	7.1	2.4	28.0	26.1	27.1	82	71	89	5.21	133.0	52.0	18th	6	...	...
Selama	79.3	86.1	77.2	88.5	72.3	...	...	92	2	70	1	84	2	75	3	2.9	6.7	1.7	28.8	28.4	28.7	87	73	92	8.07	205.0	80.5	18th	13	...	...
Lenggong	76.9	86.1	76.8	88.1	71.8	...	...	91	5	69	2	84	2	75	1	2.1	8.2	1.7	27.7	27.0	28.3	91	68	92	4.74	120.5	17.0	2nd	14	...	...
Tanjong Malim	79.6	86.8	73.5	90.3	70.3	...	...	94	2	65	1	85	1	74	1	4.2	8.3	1.0	27.0	27.6	26.3	81	67	95	5.83	148.0	65.0	8th	11	...	
Grik	76.8	83.9	75.9	89.4	72.1	...	...	94	1	69	1	82	1	75	1	2.9	7.2	2.4	26.4	26.5	26.3	86	71	88	4.66	118.5	30.7	17th	18	...	...
Klian Intan	75.3	82.7	73.5	84.7	69.5	...	...	89	1	66	1	80	1	71	1	2.2	6.5	2.0	26.1	26.3	24.8	89	73	90	9.18	233.1	35.6	12th	18	...	...
Kroh	76.7	82.9	70.1	86.1	70.4	...	...	91	1	67	1	82	4	74	1	3.3	7.4	1.0	25.7	25.2	24.2	85	69	95	8.88	225.6	52.6	12th	13	...	...
Tanjong Rambutan ...	...	...	...	90.9	71.3	...	...	93	6	70	19	88	1	79	1	...	...	...	...	...	...	.	.	..	9.68	245.9	49.0	2nd	14	...	.
Sitiawan	81.1	87.6	76.7	91.1	72.1	...	...	94	4	70	3	85	1	74	1	4.5	8.9	1.1	27.9	27.4	29.1	81	66	95	2.52	64.0	15.5	22nd	9	...	.
SELANGOR—																															
Lake Gardens, Kuala Lumpur	79.3	86.6	75.8	89.6	70.1	151.0	70.1	93	3	66	1	82	1	72	5	4.4	10.0	1.8	26.4	25.0	27.1	80	62	91	5.29	131.5	35.9	16th	11	6.13	190.10
General Hospital ...	80.3	86.6	76.8	89.4	72.3	117.0	70.6	94	1	70	1	82	1	71	3	5.3	10.1	2.8	26.0	24.8	26.5	77	62	87	5.06	128.5	36.2	16th	11	...	...
Klang	78.6	85.9	78.2	85.2	73.9	...	...	89	4	72	3	79	1	76	1	3.3	8.5	2.5	27.4	26.1	28.4	85	66	89	1.50	38.2	33.2	6th	5	...	.
Kajang ...	81.1	87.3	75.8	89.8	70.5	...	...	94	2	72	1	83	1	73	2	5.0	10.0	2.1	27.1	25.5	26.7	78	62	90	1.79	45.5	13.0	7th	8	...	...
Kuala Selangor ...	...	...	...	91.3	...	...	...	94	1	...	...	87	1	...	...	...	...	...	...	...	...	...	..	.	1.50	38.0	17.4	2nd	7	..	..
Serendah	81.5	86.8	75.5	90.5	70.3	...	...	94	2	67	1	84	1	72	6	5.6	9.8	2.0	26.6	25.4	26.6	77	62	90	3.14	79.8	22.9	16th	9	...	...
Kuala Kubu	80.7	86.9	74.2	90.0	70.4	...	...	93	6	67	3	82	1	73	2	6.4	11.0	1.3	24.8	23.9	26.5	72	78	64	6.41	162.8	62.2	12th	12	.	...
Telok Datoh	...	...	...	89.5	71.9	...	...	94	2	69	1	80	1	74	2	...	...	...	...	...	...	...	..	...	2.24	56.8	14.7	16th	7	..	...
NEGRI SEMBILAN—																															...
Seremban	81.1	85.2	77.9	90.5	71.9	...	67.0	93	5	69	1	86	1	74	1	4.1	6.9	1.8	28.6	28.2	29.2	83	72	92	1.76	44.8	13.4	6th	11	...	
Kuala Pilah	80.8	87.4	77.5	90.0	69.0	...	...	93	4	67	2	86	2	72	1	4.6	9.4	2.2	27.5	26.5	28.2	80	64	90	2.57	65.2	37.6	8th	7	...	...
Tampin	82.3	87.3	78.0	90.0	71.8		...	93	1	70	2	88	6	74	3	4.9	5.9	1.8	28.5	32.0	29.3	79	76	92	2.76	70.0	15.2	10th	10	..	..
Port Dickson	81.9	85.0	80.4	86.5	74.5	151.8	...	92	2	72	1	84	4	76	4	3.7	6.2	3.4	29.1	29.1	29.0	82	75	85	2.53	64.2	32.8	9th	8	...	...
Jelebu	82.7	85.2	78.3	87.7	70.6	...	...	90	4	68	2	85	1	73	1	5.3	5.9	2.4	28.2	29.8	27.7	78	76	89	1.83	46.4	12.0	8th	8	...	...
PAHANG—																															
Kuala Lipis	75.9	82.1	77.0	89.4	71.1	...	...	92	4	62	1	85	1	77	1	2.9	4.6	1.7	25.5	29.6	28.5	86	81	92	9.84	250.0	84.0	3rd	7	...	...
Raub	78.6	85.9	74.8	88.9	70.6	153.0	69.3	95	1	68	4	86	2	71	2	4.3	8.9	1.4	25.9	25.8	26.9	81	65	93	4.19	111.1	44.0	8th	9	..	...
Bentong	78.1	86.1	75.9	90.3	71.9	...	...	94	2	69	1	87	1	74	5	3.4	8.5	1.2	26.9	26.6	28.2	84	67	91	2.16	140.3	16.6	8th	12	...	...
Pekan	84.5	86.7	76.5	90.5	74.6	...	...	94	1	71	1	88	2	77	4	3.1	3.6	2.0	33.4	35.6	27.5	85	86	90	2.93	74.4	29.0	26th	11	...	...
Kuantan	81.1	86.3	78.0	89.2	73.5	...	...	93	2	71	2	87	1	76	1	4.7	7.2	2.3	27.6	28.8	28.5	79	71	90	1.78	45.2	13.0	21st	10	...	.:
Sungei Lembing ...	...	...	...	91.1	72.4	...	...	95	1	70	2	81	1	77	1	...	...	...	...	...	...	..	...	...	2.54	64.5	25.4	12th	8	...	...
Camerons H'lands (Tanah Rata)	60.8	69.6	62.4	71.8	55.0	144.1	52.9	76	2	49	3	66	1	61	2	1.0	5.4	1.0	16.8	17.5	17.2	94	74	94	6.72	170.7	52.6	2nd	18	4.86	150.60
" " (Rhodn Hill)	61.8	67.8	...	70.7	58.1	146.5	56.5	78	1	56	4	65	1	60	2	2.5	4.7	...	15.8	17.1	...	86	77	...	6.44	163.5	56.7	2nd	17	5.17	160.15
Fraser's Hill	65.7	71.7	61.8	74.2	61.3	145.1	58.5	78	1	59	2	70	1	63	6	3.1	5.5	1.8	17.6	18.9	18.4	85	75	90	5.20	132.1	63.0	1st	11	5.41	167.60

RAINFALL STATIONS.

Perak. —	Total.		Most in a day.	Date.	No. of rainfall days.	—	Total.		Most in a day.	Date.	No. of rainfall days.	Selangor. —	Total.		Most in a day.	Date.	No. of rainfall days.	Negri Sembilan. —	Total.		Most in a day.	Date.	No. of rainfall days.	Pahang. —	Total.		Most in a day.	Date.	No. of rainfall days.
	In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.		
Kuala Kuran	8.61	218.8	52.1	2nd	11							Sabak Pernam	4.13	105.0	52.4	26th	6	Mantin	1.67	42.5	18.5	26th	5	Tenerloh	2.53	61.2	21.1	8th	8
The Cottage	15.35	389.9	92.7	1st	11	P. Tanjong Bagan Datoh	4.30	109.3	40.5	2nd	9	Dist. Hospital K. L.	5.76	146.3	44.2	17th	12							K. Tembeling	2.09	53.0	29.0	16th	5
Maxwell's Hill	15.29	388.4	80.8	15th	14	Sungkai	6.83	173.5	80.0	2nd	5	Prisons, K. L.												Rompin	6.15	156.2	49.0	26th	12

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, SEPTEMBER, 1925.

Station.	Air Temperature in degrees Fahrenheit. Means. 9 A.M.	3 P.M.	9 P.M.	Maximum.	Minimum.	Max. in sun (black bulb in vacuo.)	Minimum on grass.	Absolute Extremes. Highest max.	No. of days.	Lowest min.	No. of days.	Lowest max.	No. of days.	Highest min.	No. of days.	Humidity. Means. Depression of Wet Bulb. 9 A.M.	3 P.M.	9 P.M.	Vapour Pressure. 9 A.M.	3 P.M.	9 P.M.	Percentage. 9 A.M.	3 P.M.	9 P.M.	Rainfall. Total.		Most in a day. Amount.	Date.	No. of Rainfall days.	Bright Sunshine. Daily mean.	Total.
PERAK—																			m.b.	m.b.	m.b.	%	%	%	In.	m.m.	m.m.			Hrs.	Hrs.
Taiping	81,4	83,0	78,0	89,0	73,4	153,7	70,2	92	1	70	1	83	1	79	3	4,2	5,5	2,1	27,8	27 3	28,9	82	77	91	15,71	399,0	57,5	22nd	23	...	...
Kuala Kangsar	78,5	85,5	77,2	89,2	73,4	...	...	92	6	71	2	84	1	76	1	3,0	7,7	1,8	27,8	27,0	28,5	86	69	92	7 80	198 1	61,2	30th	19	...	...
Batu Gajah	79,7	85,4	77,3	90,2	73,1	150,9	...	94	1	70	1	83	2	75	5	3,8	7,3	2,2	27,7	27 8	28,0	83	71	90	8,50	215,9	45,6	19th	19	...	...
Gopeng	79,7	85,1	77,0	89,1	73,9	...	...	93	2	68	1	84	2	77	4	4,2	7,9	2,2	27,0	26,6	27,7	81	68	90	15,19	385,8	51 0	15th	22	...	...
Ipoh	81,6	85,2	76,5	90,3	72,5	...	...	96	1	70	2	83	1	76	1	4,6	7,8	1,4	27,3	26,8	28,6	80	69	93	6,85	174 0	46,5	20th	21	...	...
Kampar	78,9	83,9	76,1	89,3	72,2	...	...	92	4	70	5	83	1	76	1	4,2	7,8	1,8	26,3	25,6	27,4	81	68	91	13,33	338 7	52 2	8th	24	...	...
Teluk Anson	80,3	84,7	77,0	88,6	73,[illegible]	...	...	92	1	69	1	84	3	76	1	3,7	7,5	2,2	28,5	26,8	27,7	84	70	90	12,18	309,3	42,4	21st	19	...	...
Tapah	80,3	84,4	75,0	89,8	71,6	...	...	93	1	68	1	84	1	75	1	4,8	7,1	1,1	27,6	27,0	27,5	79	71	95	15,38	390,7	46,0	19th	26	...	...
Parit Buntar ..	82,1	87,1	78 8	90,0	74,1	...	...	92	2	71	1	87	3	77	1	5,0	7,2	1,7	28,2	29,6	30,2	79	72	92	10 03	251 7	67,5	4th	12	...	...
Bagan Serai	81,0	85,5	75,[illegible]	87,6	74,3	...	...	90	1	72	3	83	1	78	1	3,7	7,6	0,8	29,1	27,4	28,6	84	69	96	10,52	267,[illegible]	58,5	2nd	12	...	...
Selama .	79,2	85,4	76,1	88,2	72,9	...	...	90	6	70	2	83	1	75	4	2,6	6,4	1,2	29,1	29 1	28,4	89	74	94	28 60	726,5	127,2	30th	21	...	...
Lenggong	77,1	85,	76,8	87 9	72,6	...	...	90	4	69	1	82	1	75	2	2,3	6,8	1,8	27,9	28,9	28,1	89	73	92	6.31	163 0	27,5	27th	11	...	...
Tanjong Malim ..	79 4	83 9	72,7	89,2	70,3	...	...	92	4	68	2	83	1	73	1	3,8	7,1	0,7	27,4	26 6	26,1	83	71	96	14,81	376,0	41 5	27th	21	...	...
Grik	78 3	84,6	75,6	89,5	72,9	...	...	92	4	71	5	84	2	76	1	3,7	7,5	1,9	26,5	26 7	26,9	83	70	91	10,00	254 1	55,0	20th	19	...	...
Klian Intan	75,6	82 4	73,4	85,4	70,2	...	...	88	3	68	1	81	1	72	5	2,1	6,1	1,9	26,5	26,2	24 9	90	73	90	7,09	180,1	35 2	1th	18	...	...
Kroh ...	77 6	81,3	70,0	86,2	70,2	...	...	91	3	69	7	81	1	72	4	3,7	6,5	1,0	25 9	25 1	23,1	83	73	95	10,31	261,9	36 2	25th	19	...	...
Tanjong Rambutan ...	...	..	...	...	..	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	13,46	341 9	52,4	9th	16	...	...
Sitiawan ..	80,5	85,8	77,0	87,9	72,8	...	...	91	1	70		85	1	75	2	3,8	7,1	1,0	28,5	28 5	29,6	84	[illegible]	95	9,07	230,4	56,2	16th	19	...	...
SELANGOR—																															
Lake Gardens, Kuala Lumpur	80 2	82,7	75,2	89,0	70 5	151,9	70,2	92	4	68	1	85	3	73	1	4,7	6,9	1,0	26,8	25 8	27 9	79	71	95	12,03	305,6	49 6	11th	21	5,05	151,55
General Hospital ...	80,9	82,7	76,2	88,8	72 2	150 6	71,0	93	1	70	1	85	2	71	3	5,3	6 6	1,9	26 7	26,2	27 3	77	73	91	15,85	402,5	71,3	14th	[illegible]	...	...
Klang	78,9	82,8	77,7	84,6	73,9	...	...	89	3	72	3	81	1	76	1	3,1	5,7	1,9	28,1	25,9	28,9	86	76	91	8 83	221,2	62,0	11th	11	...	...
Kajang ...	80,8	83,2	75,3	89,5	71,1	...	...	93	3	69	3	85	1	74	1	1,9	6,4	1,2	27,0	27,0	27,6	78	73	94	12,37	311 2	52 6	10th	21	...	...
Kuala Selangor	...	...	...	87,9	72,6	...	...	93	1	71	2	81	1	74	2	...	...	...	..	...	...	..	..	...	7,60	193 1	49 0	12th	16	...	...
Serendah	81,2	82,1	75,1	90,0	70,8	...	...	93	2	69	3	87	2	71	1	5,3	6 5	1,4	26,8	25,8	27,1	77	73	93	18 08	459,2	65,3	26th	21	...	...
Kuala Kubu . ..	80,0	81,2	73,9	89,5	71,5	...	...	93	1	68	2	83	2	78	1	5,3	5,7	0,9	25,7	26,1	26,8	77	75	96	13 53	343,7	56 9	21st	19	..	...
Telok Datoh	...	...	...	88,8	72,5	...	...	94	1	71	6	84	2	75	1	...	...	...	...	...	..	...	...	.	12 58	319 6	52,6	22nd	17	..	...
NEGRI SEMBILAN—																															
Seremban	80,9	83,2	77,6	89,6	72,1	...	67,1	93	1	70	3	87	2	75	2	4,2	5 9	1,6	28,2	27,7	29 2	82	75	93	15 83	402 2	46 6	26th	23	..	..
Kuala Pilah	81,3	87 2	77,4	90,2	69,7	...	...	93	3	68	7	86	3	72	3	4,9	9 0	2,1	27,5	26,9	28,2	78	65	90	9,44	239,8	67,0	10th	19	...	...
Tampin	80,2	81,3	78,3	87,7	71,3	...	...	91	1	70	9	85	6	75	1	4,2	3,3	2,9	29,4	30,1	27,8	81	86	86	11,16	283 4	65 8	7th	18	...	..
Port Dickson	80,1	83 8	79,8	85,7	74,3	152,0	...	90	1	72	2	84	7	76	3	3,7	5,3	3,3	28,6	29 3	28,7	84	78	86	8,24	209 1	33 0	12th	13	...	.
Jelebu . ..	83 5	85 5	78,2	88,4	71,3	...	..	93	1	69	1	85	1	73	4	6,9	7,8	3,9	26,5	27,0	26,1	71	69	82	3,39	86,0	22 1	30th	[illegible]	..	..
PAHANG—																															
Kuala Lipis	75,9	84,3	[illegible]	91,5	73,1	...	...	95	2	70	2	89	3	76	3	2 1	5,3	1,7	26,3	29,8	28,1	88	78	92	9,73	247 2	68,0	12th	12	...	...
Raub .	78 5	81,2	74,5	88 2	70,9	154 8	70,0	92	2	69	3	84	1	73	3	3 6	6 8	1,1	26,9	27,3	27,0	84	72	95	6,78	172 1	33,4	[illegible]	[illegible]	...	...
Bentong ..	78 2	83 6	75,6	88 6	70,2	...	..	92	1	67	1	83	1	71	1	3 3	6,1	1 3	27 0	27,9	27,8	85	75	91	3,69	[illegible]	21 8	11th	17	...	..
Pekan ...	83,3	88,4	75,3	90,5	73,5	...	...	93	5	72	7	89	10	75	8	[illegible]	9,1	2,0	30,4	27,9	26,4	82	66	90	7,32	185,9	34,[illegible]	13th	8	..	...
Kuantan	81,2	86,0	77 2	89,7	73,[illegible]	...	...	94	1	70	1	87	1	75	8	4,0	6,7	2,0	27,9	29,2	28,2	83	73	91	7 94	[illegible]	47,0	29th	12	...	..
Sungei Lembing ..	..	..	..	91,6	71,9	...	..	95	2	69	1	88	1	77	1	...	...	...	..	...	...	...	...	...	13,05	331,5	77 7	14th	19	..	..
Camerons H'lands (Tanah Rata)	62,2	68,4	62,5	70 9	55,5	144,7	55,5	75	1	52	4	67	3	62	1	0,8	3,8	0,8	17 9	18,4	18 1	95	82	95	15 01	382,0	58,9	22nd	25	3,98	119,45
" " (Rhodn. Hill)	6[illegible] 4	66 4	...	70,2	58,0	138,1	55 5	75	1	55	1	64	1	60	4	1,9	2,9	...	16,8	18,2	...	90	85	.	15,57	395,6	79,3	22nd	26	1 42	132,50
Fraser's Hill ..	66,3	69,8	66,3	72,7	61,2	144,2	58,9	76	1	59	2	70	4	64	1	2,5	3,5	1,3	18 7	19,9	18 9	87	83	93	11,77	299,0	53,[illegible]	10th	20	3,86	115,75

RAINFALL STATIONS

Perak.	Total.		Most in a day.	Date.	No. of rainfall days.	Perak.	Total.		Most in a day.	Date.	No. of rainfall days.	Selangor.	Total.		Most in a day.	Date.	No. of rainfall days.	Negri Sembilan.	Total.		Most in a day.	Date.	No. of rainfall days.	Pahang.	Total.		Most in a day.	Date.	No. of rainfall days.
	In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m	m.m.				In.	m.m.	m.m				In.	m.m	m.m		
Kuala Kurau	13,05	331,4	90,6	4th	13	P. Tanjong Bagan Datoh	6,28	159,6	74,0	29th	15	Sabak Pernam	8,80	223,6	44,6	5th	11	Mantin	9,39	238,4	79,8	11th	15	Temerloh	2,98	235,6	47,0	26th	17
The Cottage	28,11	714,9	74,9	21st	24							Dist. Hospital, K.L.	13.45	341.6	63,3	11th	21							K. Tembeling	1,07	163,1	20,6	20th	14
Maxwell's Hill	20,14	511,6	62,2	29th	25	Sungkai	15,24	387,0	68,0	19th	22	Prisons, K.L.												Rompin	9,28	75,6	26,8	10th	7

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, OCTOBER, 1925.

Station.	Air Temperature in degrees Fahrenheit. Means. 9 A.M.	3 P.M.	9 P.M.	Maximum.	Minimum.	Max. in Sun (black bulb in vacuo.)	Minimum on grass.	Absolute Extremes. Highest max.	No. of days.	Lowest min.	No. of days.	Lowest max.	No. of days.	Highest min.	No. of days.	Humidity. Means. Depression of Wet Bulb 9 A.M.	3 P.M.	9 P.M.	Vapour Pressure. 9 A.M.	3 P.M.	9 P.M.	Percentage. 9 A.M.	3 P.M.	9 P.M.	Rainfall. Total.		Most in a day. Amount.	Date.	No. of Rainfall days.	Bright Sunshine. Daily mean.	Total.
	°	°	°		°	°	°	°		°		°		°			°	°	m.b.	m.b.	m.b.	%	%	%	In.	m.m.	m.m			Hrs.	Hrs
PERAK—																															
Taiping	80,6	79,7	76,4	87,7	72,2	156,0	70,5	91	2	69	1	80	1	78	1	4,8	3,3	1,7	27,0	28,6	27,9	79	85	92	27,93	709,5	117,5	5th	27	...	...
Kuala Kangsar	78,4	82,7	75,3	89,1	72,5	...	...	93	1	71	4	84	2	74	4	3,3	6,1	1,1	27,2	27,0	27,8	85	75	95	12,09	307,1	67,2	23rd	28	...	...
Batu Gajah	78,6	84,0	77,7	88,9	72,8	151,2	...	92	5	70	2	83	1	78	1	3,7	7,7	3,4	26,8	25,8	26,5	83	69	81	13,79	350,2	67,0	4th	19	...	...
Gopeng	78,7	84,3	76,6	87,4	72,4	...	...	91	3	70	1	84	1	75	1	3,4	8,2	2,0	27,4	25,9	27,6	84	67	91	13,99	355,3	62,4	4th	24	..	...
Ipoh	79,5	82,4	75,4	88,9	72,0	...	...	92	6	69	1	83	2	73	11	4,2	6,1	0,9	26,9	26,7	28,3	81	75	96	11,46	291,1	65,0	31st	23	...	...
Kampar	78,4	84,5	76,1	88,6	72,7	...	...	93	1	70	1	84	1	79	1	3,7	7,4	1,8	26,6	26,7	27,4	83	70	91	12,79	325,0	66,5	1st	27	...	...
Teluk Anson	78,8	81,4	76,5	87,4	75,0	...	...	91	2	71	1	83	2	78	4	5,3	6,9	1,6	27,6	27,2	28,2	85	71	93	19,89	505,3	104,0	9th	21	...	...
Tapah	79,5	84,7	75,1	88,4	72,5	...	...	93	1	69	1	83	1	80	1	4,3	7,7	1,0	26,7	26,5	27,8	81	69	95	19,58	497,3	92,0	22nd	25	...	...
Parit Buntar ...	80,1	82,7	76,8	87,1	72,8	...	...	90	1	71	4	80	1	76	1	4,1	5,8	1,3	27,6	27,4	29,0	82	76	94	20,28	515,0	116,0	5th	23	...	...
Bagan Serai	80,5	82,4	76,3	87,1	73,3	...	...	90	1	70	1	80	1	75	7	1,0	5,5	1,9	28,2	26,7	27,4	82	77	91	20,10	510,5	125,8	5th	17	...	...
Selama	78,4	82,3	75,9	85,8	73,1	...	...	90	2	70	1	80	2	75	3	2,2	4,3	1,3	29,0	29,4	28,1	90	82	94	22,67	575,7	83,2	23rd	24	...	...
Lenggong	77,3	82,6	75,1	86,4	72,7	...	...	89	3	70	2	81	1	75	2	2,0	5,4	1,0	28,3	28,0	27,8	91	77	95	13,17	334,5	57,0	25th	25	...	...
Tanjong Malim	78,5	81,7	72,9	88,3	71,1	...	...	92	1	70	8	81	1	73	2	3,3	6,8	0,8	27,3	27,9	26,1	85	73	96	22,76	578,0	98,0	16th	25	...	...
Grik	77,3	82,0	74,6	87,6	72,0	...	...	92	1	70	3	84	2	75	1	3,4	6,1	0,8	26,1	26,3	27,6	81	75	96	14,29	365,5	62,5	6th	25	...	...
Klian Intan	74,7	79,7	72,0	84,2	69,3	...	...	88	2	66	1	79	1	71	6	2,3	5,2	1,6	25,4	25,6	24,2	89	77	92	17,53	445,3	64,8	25th	27	...	...
Kroh	76,2	80,0	69,3	83,7	70,2	...	...	89	1	68	2	79	1	72	1	2,8	5,6	1,0	26,0	21,5	22,7	87	76	95	16,15	410,2	44,5	5th	27	...	...
Tanjong Rambutan ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12,73	323,4	70,4	6th	17	...	...
Sitiawan	80,4	84,3	76,6	87,9	73,3	...	...	92	1	71	1	82	1	75	3	3,8	6,8	1,2	28,1	27,4	28,9	81	72	91	14,94	379,6	79,5	5th	20	...	...
SELANGOR—																															
Lake Gardens, Kuala Lumpur	79,3	83,1	75,8	88,3	71,6	156,1	71,5	92	1	69	1	82	1	74	1	3,9	6,7	1,1	27,3	26,4	28,3	82	72	95	9,80	248,8	37,8	28th	22	4,07	26,25
General Hospital ...	79,8	82,7	76,6	87,9	73,2	150,1	72,2	92	3	71	2	83	1	75	1	1,5	6,3	1,7	27,6	26,7	28,1	80	74	92	10,50	266,6	37,9	4th	26	...	...
Klang	77,7	82,7	77,4	83,7	74,2	...	...	87	1	69	1	81	5	76	1	2,3	5,6	2,0	28,2	27,8	28,1	89	77	91	10,93	277,5	54,5	18th	18	...	...
Kajang	80,2	83,0	75,3	89,1	72,1	...	...	92	3	70	1	86	2	74	1	1,4	6,3	1,0	27,2	27,0	28,0	80	74	95	8,01	203,5	48,8	18th	20	...	...
Kuala Selangor	...	...	...	87,3	72,6	...	...	89	6	72	11	84	2	74	3	...	...	...	...	...	...	..	.	...	13,02	330,7	76,0	4th	17	...	...
Serendah	80,2	82,9	75,6	89,3	71,8	...	...	91	11	70	2	86	1	73	8	4,6	6,3	1,7	27,0	26,9	27,1	80	71	92	9,78	248,4	103,6	4th	21	...	.
Kuala Kubu	79,6	81,8	74,0	88,7	70,6	...	...	92	1	69	2	85	1	72	4	4,6	5,8	0,7	26,4	26,6	27,2	80	76	97	20,55	522,0	124,2	4th	23	...	...
Telok Datoh	...	...	...	88,9	72,7	...	...	93	1	71	1	85	2	74	5	...	...	...	...	...	...	...	...	...	9,35	237,4	27,3	19th	20	...	...
NEGRI SEMBILAN—																															
Seremban	79,9	83,6	77,8	88,8	72,5	...	71,1	92	1	71	3	84	2	74	4	3,2	5,8	1,7	28,9	26,5	29,2	86	76	92	9,27	235,4	38,0	7th	25	...	...
Kuala Pilah	80,3	85,5	75,6	88,9	70,2	...	...	91	3	68	2	85	1	72	1	4,3	7,9	1,9	27,5	27,9	26,9	81	68	91	9,80	249,0	43,0	22nd	19	...	...
Tampin	80,7	83,5	77,3	89,2	72,9	...	...	94	1	70	1	85	2	75	3	3,7	5,6	2,9	28,9	26,7	26,9	84	77	86	11,41	289,6	52,2	17th	21	...	...
Port Dickson	79,4	83,7	79,8	85,2	74,0	151,1	...	86	13	72	2	84	5	75	8	3,1	5,2	3,7	28,6	30,0	28,0	86	78	83	12,08	306,8	54,4	17th	22	...	...
Jelebu	82,1	83,1	77,9	86,1	72,0	...	...	89	2	70	3	84	1	71	3	5,1	4,4	3,6	28,0	30,1	26,3	79	81	81	6,98	177,2	39,2	18th	13	...	...
PAHANG—																															
Kuala Lipis	76,0	84,8	76,2	89,7	73,5	...	...	92	1	70	1	87	3	76	2	2,2	4,8	1,4	26,7	31,3	28,2	89	80	93	20,48	520,1	61,0	19th	22	...	..
Raub	77,5	81,7	74,6	86,8	71,3	154,8	...	90	2	69	2	83	1	73	3	2,9	5,0	1,4	27,0	27,8	26,7	86	79	93	12,26	311,4	44,3	23rd	29	...	..
Bentong	78,2	81,1	75,4	88,0	69,7	...	...	91	1	68	4	86	4	71	8	3,2	5,4	0,9	27,2	27,3	28,3	85	77	96	4,25	276,5	13,8	20th	22	...	...
Pekan	81,9	84,6	74,4	89,5	73,7	...	...	93	1	71	1	83	1	76	1	4,2	5,7	1,9	28,3	29,5	25,7	82	77	91	15,02	381,6	82,4	25th	20	...	...
Kuantan ...	79,7	84,1	76,0	88,6	73,3	...	...	92	1	71	1	86	2	78	1	4,4	5,2	1,8	26,8	29,8	27,3	80	78	91	13,87	352,4	124,0	26th	21	...	...
Sungei Lembing ...	...	..	..	89,0	72,1	...	..	93	2	71	4	85	1	77	1	...	...	...	...	..	...	...	...	..	19,36	491,7	70,3	13th	26	...	...
Camerons H'lands (Tanah Rata)	62,7	67,2	62,1	70,2	56,5	138,5	54,9	75	1	51	1	66	1	60	2	1,0	2,7	0,6	18,0	19,0	18,1	95	86	93	17,15	435,5	51,0	4th	29	2,71	81,10
" " (Rhodn. Hill)	62,1	64,9	...	69,6	57,8	138,3	56,6	75	1	54	1	64	1	59	10	1,5	1,7	...	17,1	18,7	..	92	91	...	15,88	402,5	45,7	3rd	29	2,75	85,10
Fraser's Hill	67,9	71,7	61,2	72,2	60,9	144,0	59,4	77	1	58	1	67	1	64	1	2,2	3,1	0,8	20,2	21,6	19,3	89	86	96	15,95	405,1	71,6	31st	26	3,09	95,85

RAINFALL STATIONS

Perak. —	Total. In.	Total. m.m.	Most in a day. m.m.	Date.	No. of rainfall days.	Perak. — —	Total. In.	Total. m.m.	Most in a day. m.m.	Date.	No. of rainfall days.	Selangor. —	Total. In.	Total. m.m.	Most in a day. m.m.	Date.	No. of rainfall days.	Negri Sembilan. —	Total. In.	Total. m.m.	Most in a day. m..m	Date.	No. of rainfall days.	Pahang. —	Total. In.	Total. m.m.	Most in a day. m.m.	Date.	No. of rainfall days.
Kuala Kurau	22,26	565,5	106,3	5th	22	P. Tanjong						Sabak Bernam	18,55	471,2	137,8	5th	15	Mantin	8,60	218,4	30,4	4th	17	Temerloh	11,96	303,7	78,0	14th	20
The Cottage	42,18	1,071,4	124,5	7th	27	Bagan Datoh	12,13	308,2	88,3	5th	16	Dist. Hospital, K.L.	10,26	260,5	43,6	4th	21							K. Tembeling	6,94	176,1	33,5	26th	20
Maxwell's Hill	23,86	606,1	107,5	6th	22	Sungkai	17,36	441,0	122,0	4th	23	Prisons, K.L.												Rompin	14,22	361,2	123,0	25th	16

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, NOVEMBER, 1925.

Station.	Air Temperature in degrees Fahrenheit. Means. 9 A.M.	3 P.M.	9 P.M.	Maximum.	Minimum.	Max. in Sun (Black bulb in vacuo).	Minimum on grass.	Absolute Extremes. Highest max.	No. of days.	Lowest min.	No. of days.	Lowest max.	No. of days.	Highest min.	No. of days.	Humidity. Means. Depression of Wet Bulb. 9 A.M.	3 P.M.	9 P.M.	Vapour Pressure. 9 A.M.	3 P.M.	9 P.M.	Percentage. 9 A.M.	3 P.M.	9 P.M.	Rainfall. Total.		Most in a day. Amount.	Date.	No. of rainfall days.	Bright Sunshine. Daily mean.	Total.
	°	°	°	°	°	°	°	°		°		°		°		°	°		m.b.	m.b.	m.b.	%	%	%	In.	m.m.	m.m.			Hrs.	Hrs.
PERAK—																															
Taiping	81,0	80,0	76,1	88,0	72,1	156,0	71,3	91	1	68	1	81	1	75	1	4,3	3,2	1,4	28,2	28,9	27,9	82	86	93	33,01	838,5	88,0	26th	27	...	..
Kuala Kangsar	78,5	84,9	75,2	89,4	72,7	...	...	93	2	70	1	78	1	74	8	3,4	7,4	1,0	27,2	27,1	27,9	84	70	95	18,71	475,2	88,4	22nd	22	...	.
Batu Gajah	79,0	83,2	75,7	89,4	73,1	148.7	...	92	2	71	4	82	1	78	1	3,8	6,1	1,4	27,0	27,4	27,7	83	75	93	21,03	534,1	60,8	30th	23	...	...
Gopeng	79,5	83,5	76,8	87,5	72.9	...	...	90	5	70	2	82	1	75	3	4,0	6,7	2,1	27,3	26,8	27,6	82	72	90	19,81	503,1	53,6	1st	28	...	..
Ipoh	79,5	83,5	75,5	89,9	72,1	...	...	93	1	70	1	86	1	74	3	2,5	4,5	0,2	29,6	30,3	29,5	89	81	99	25,52	648,2	85,5	28th	25	...	
Kampar	79,0	82,6	75,1	89,7	72,3	...	...	94	3	70	1	83	1	77	1	4,0	6,1	0,2	26,7	26,9	29,1	82	75	99	31,63	803,4	86,0	16th	27	...	...
Telok Anson	78,7	82,5	75,4	87,8	75,9	...	...	91	1	73	1	81	1	79	1	2,8	5,2	1,0	28,4	28,2	28,1	87	78	95	19,56	496,9	68,0	22nd	25	...	...
Tapah	80,1	82,9	75,0	88,7	73,2	...	...	92	1	69	1	85	5	79	2	4,5	6,0	1,3	27,0	27,3	27,2	80	75	94	28,51	724,2	129,0	15th	28	...	...
Parit Buntar	80,9	82,2	76,0	87,0	72,4	...	...	89	5	69	1	80	1	74	4	4,4	4,7	1,3	27,9	28,8	28,2	80	80	94	19,27	489,5	110,0	30th	24	...	...
Bagan Serai	80,8	82,4	75,7	88,3	74,5	...	...	90	1	72	1	85	4	77	3	4,1	5,4	1,6	28,3	27,8	27,4	83	79	92	22,19	571,3	94,0	30th	20	...	.
Selama	78,9	82,0	76,0	86,2	73,5	...	...	90	2	70	1	77	1	75	6	1,9	4,1	1,2	29,1	29,5	28,3	91	85	94	24,68	880,9	155,8	28th	24	...	..
Lenggong	77,1	83,8	76,0	86,5	72,8	...	...	90	2	68	1	82	1	74	11	2,2	5,5	1,6	28,1	29,0	27,7	90	77	92	16,59	421,5	181 0	21st	17	...	...
Tanjong Malim	79 4	83,0	72,7	88,5	73,4	...	...	92	1	68	2	81	1	73	1	3,4	6,0	0,7	28,1	27,4	26,1	84	75	96	32,54	826,5	157,5	25th	26	...	...
Grik	77,0	82,3	74,7	87,2	71,3	...	...	92	3	66	1	80	2	73	2	3,3	5,8	0,8	26,0	27,0	27,7	85	76	96	8,39	213,0	30,0	2nd	23	...	..
Klian Intan	74,7	79,7	72,0	84,7	68,7	...	...	88	3	65	1	79	1	71	1	2,7	4,5	1,4	24,9	26,6	24,6	87	80	93	10,73	272,6	28,6	28th	24	...	...
Kroh	76,3	80,4	69,5	83,9	...	...	...	89	1	...	...	75	1	...	...	3,1	6,0	1,0	25,6	25,0	22,6	86	71	95	11,02	279,9	45,0	22nd	23	...	...
Tanjong Rambutan ...	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17,37	441,1	39,0	15th	24	...	.
Sitiawan	80,9	83,3	75,2	88,3	73,0	...	...	90	1	71	1	80	1	75	1	2,7	5,0	1,1	30,7	29,3	27,7	88	79	95	16,22	412,0	81,0	26th	24	...	...
SELANGOR—																															
Lake Gardens, Kuala Lumpur	79.7	84,4	75,4	88,8	71,5	154,1	71,3	93	1	69	2	86	3	73	4	3,9	7,4	0,9	27,5	26,6	28,3	82	70	96	17,56	446,0	80,6	29th	27	5,30	158,95
General Hospital ...	80,3	83,6	75,9	87,8	72,9	119,7	72,0	92	1	71	2	84	1	75	2	4,4	6,7	1,4	27,3	26,9	27,9	80	72	93	17,26	438,4	82,8	30th	27	...	...
Klang	78,3	82,7	77,1	83,6	73,4	...	...	86	1	71	2	79	2	71	1	2,7	5,3	1,4	28,1	28,2	29,0	87	78	93	20,73	526,5	106,5	30th	23	...	.
Kajang	80,4	84,4	75,1	90,2	71,7	...	...	93	1	69	2	88	2	74	1	4,3	6,6	0,9	27,6	27,8	28,0	81	74	96	18,27	464,1	68,8	30th	28	..	...
Kuala Selangor ...	82,0	83,0	74,5	87,5	72,7	...	...	89	4	71	1	85	1	73	22	5,5	6,9	0,8	27,2	26,1	27,5	77	71	96	22,42	569,5	85,1	30th	23	...	
Serendah	79,7	81,7	75,2	89,5	71,6	...	...	93	1	69	1	86	3	71	1	4,1	5,5	1,2	27,2	27,0	27,5	8.	77	91	24,75	628,7	60,2	27th	26	...	.
Kuala Kubu	79,7	81,6	73,7	88,6	70,6	...	...	92	2	68	1	80	1	72	8	4,9	5,1	0,5	26,1	27,5	27,2	78	78	98	26,44	671,6	99,8	30th	29	..	.
Telok Datoh	...	...	...	88,3	72,4	...	...	91	2	70	1	82	1	74	2	...	...	..	...	. .	...	...	...	...	23,87	606,2	76,8	25th	21	...	...
NEGRI SEMBILAN—																															
Seremban	81,4	83,2	75,8	88,2	71,9	...	...	90	6	69	1	86	4	74	2	4,4	5,3	1,0	28,1	28,7	28,5	81	78	95	16,56	420,6	88,5	14th	28	...	
Kuala Pilah	80,6	85,1	75,3	88,3	70,5	...	...	91	1	70	4	85	1	72	1	4,0	7,3	1,7	27,7	27,5	26,9	82	71	92	11,67	296,5	57,0	25th	24	...	
Tampin	81,9	81,9	76,3	88,8	72,0		...	91	4	70	6	84	1	75	4	5,4	1,7	1,3	27,3	28,5	28,5	77	80	94	19,18	487,1	80,2	10th	24	...	..
Port Dickson	81,7	83,3	80,3	86,0	73,9	157,3	...	88	1	72	1	85	5	75	7	3,9	5,9	3,5	29,5	27,8	28,2	83	75	85	5,67	143,6	50,4	29th	10	...	...
Jelebu	79,3	82,2	76,9	88,8	72,0	...	...	91	1	70	1	86	4	74	1	4,0	5,3	2,3	27,0	27,8	27,4	82	78	89	11,35	364,4	77,2	30th	25	...	...
PAHANG—																															
Kuala Lipis	77,1	84,0	76,4	88,3	74,2	...	...	91	3	70	1	86	1	79	1	2 8	5,7	1,4	26,8	28,8	28,4	87	76	93	21,60	548,7	80,4	17th	15	...	..
Raub	77,7	82,7	74,4	86,1	71,7	154 5	70,9	90	1	69	1	84	2	73	8	2,9	5,9	0,9	27,2	28,2	27,2	86	75	96	18,38	466,9	50,5	16th	29	...	..
Pentong	78,7	81,1	75,2	88,4	70,0	...	...	90	2	67	1	86	2	73	1	3,6	4,0	1,1	27,0	28,8	27,7	84	83	95	12,65	582,7	33,3	30th	27	...	...
Pekan	80,8	83,3	75 2	90,3	74,1	...	...	92	6	72	1	87	1	75	10	2,9	3,0	2,0	30,2	32,7	26,3	87	87	90	15,61	396,6	59,6	7th	15	...	...
Kuantan	79,6	84,0	76,1	86,9	73,1	...	...	89	5	71	1	80	1	76	1	3,7	5,4	1,5	26,9	29,3	27,9	83	77	93	14,06	357,1	56,6	22nd	27	...	..
Sungei Lembing ...	...	...	...	86,7	73,3	...	...	89	3	70	1	82	1	78	1	...	...	...	...	...	...	...	...	...	21,57	517 9	60,2	5th	19	...	...
Camerons H'lands (Tanah Rata)	63,0	67,3	62,3	70,6	56,8	135,2	55,2	75	1	48	1	63	1	61	1	1,2	2,8	0,6	18,0	19,7	18,2	94	86	97	25,31	642,8	105,8	28th	27	2,71	81,40
,, ,, (Rhodn Hill)	62,9	65,4	...	69,9	58,1	136,2	56,9	74	2	55	1	61	1	60	5	1,9	2,0	...	17,1	18,7	...	90	83	...	24 35	618,4	102,1	28th	27	2,70	81 10
Fraser's Hill	65,0	69,2	64,1	71,6	61,2	139,5	60,3	75	1	59	1	67	1	63	1	1,4	2,9	0,6	19,1	20,2	19,5	93	86	97	29,87	758,7	87 9	29th	28	3,08	92,15

RAINFALL STATIONS.

Perak. —	Total.		Most in a day.	Date.	No. of rainfall days.	Selangor. —	Total.		Most in a day.	Date.	No. of rainfall days.	Negri Sembilan. —	Total.		Most in a day.	Date.	No. of rainfall days.	Pahang. —	Total.		Most in a day.	Date.	No. of rainfall days.
	In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.				In.	m.m.	m.m.		
Kuala Kurau	21,17	537,8	132,1	26th	20	P. Tanjong						Sabak Pernam	21,70	551,2	86,9	15th	22	Mantin	18,20	462,2	113,4	11th	24	Temerloh	7,30	185,4	33,8	26th	15
The Cottage	45,30	1,150 6	133,1	22nd	27	Bagan Datoh	15,48	393,1	94,2	15th	25	Dist. Hospital K. L.	16,37	478,8	70,8	26th	25							K. Tembeling	4,70	119,1	11,8	20th	25
Maxwell's Hill	38,76	984,5	151,9	22nd	24	Sungkai	23,11	587,0	89,0	16th	27	Prisons, K. L.												Rompin					

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, DECEMBER, 1925.

Station.	Air Temperature in degrees Fahrenheit. Means. 6 A.M.	3 P.M.	9 P.M.	Maximum.	Minimum.	Max. in Sun (black bulb in vacuo.)	Minimum on grass.	Absolute Extremes. Highest max.	No. of days.	Lowest min.	No. of days.	Lowest max.	No. of days.	Highest min.	No. of days.	Humidity. Means. Depression of Wet Bulb 9 A.M.	3 P.M.	9 P.M.	Vapour Pressure. 9 A.M.	3 P.M.	9 P.M.	Percentage. 9 A.M.	3 P.M.	9 P.M.	Rainfall. Total.		Most in a day. Amount.	Date	No. of Rainfall days	Bright Sunshine. Daily mean.	Total.
PERAK—	°	°	°	°	°	°	°	°		°		°		°		°	°	°	m.b.	m.b.	m.b.	%	%	%	In.	m.m.	m.m			Hrs.	Hrs.
Taiping	80,5	83,4	76,9	89,[illegible]	72,0	153,0	71,3	92	3	69	2	83	1	75	4	4,9	5,5	1,6	26,7	27 6	28,6	78	77	93	16,08	406,0	59,0	5th	20	...	...
Kuala Kangsar	78,4	86,7	76,0	89,3	71,5	...	...	93	1	68	1	82	1	73	6	3,3	9,8	1,6	27,2	25,3	27,7	85	62	92	3,85	97 8	31,8	14th	13	...	...
Batu Gajah	78,5	85,2	76,0	89,3	71,8	146,8	...	92	3	70	5	79	1	75	1	4,3	8,5	1,7	25,8	25 8	27,5	81	66	92	13,43	341,2	70,0	4th	16	...	...
Gopeng	79,2	85,8	77,6	88,0	72,6	...	...	92	2	66	1	79	1	75	2	4,1	8,8	2,5	26,8	25,9	27,8	82	65	88	5,51	139,9	35,0	12th	22	...	...
Ipoh	78,8	86,3	76,1	90,2	71,3	...	...	94	1	69	2	86	1	73	6	3,7	6,5	0,8	27,0	29,9	29,0	83	74	96	9,09	230,8	37,8	20th	19	...	...
Kampar ...	78,7	85,5	76,5	89,8	72,5	...	...	95	1	70	4	86	2	76	4	4,1	9,4	1,8	26,3	24,7	27,8	82	63	92	10,20	259,0	61 0	12th	18	...	...
Teluk Anson	78,6	84,8	76,8	88,5	76,3	...	...	93	1	73	1	80	1	79	1	3,1	6,9	1,5	27,8	27,8	28,7	82	72	93	6,55	166,5	26,0	28th	19	...	...
Tapah	79,7	86,7	75,6	88,6	72,5	...	...	92	2	68	1	83	1	79	1	4,1	9,3	1,3	27,2	26,0	27,8	82	64	94	8.15	207,0	36,5	29th	22	...	...
Parit Buntar ...	79,9	85,1	77,5	86,7	71,8	...	...	90	1	70	5	81	2	74	3	3,9	7,3	1,6	27,8	27,5	29,1	82	71	93	4,02	102,0	50,5	3rd	12	...	...
Bagan Serai	80,8	86,4	77,8	88,8	74,1	...	...	91	5	71	1	85	2	79	1	1,5	9,1	3,5	27,6	25,9	26,3	80	64	84	8 70	221,1	39,0	30th	12	...	...
Selama	77,9	85,3	77,0	88,8	73,5	...	...	94	3	70	3	81	2	77	1	2,3	6,9	1,6	28,4	28,3	28,7	90	72	93	12,26	311,4	90,8	11th	18	...	...
Lenggong	77,7	85,4	76,7	87,4	70,1	...	...	92	4	67	3	81	1	73	4	2,5	8,4	1,8	27,9	26,1	28,0	88	66	92	5,37	136,5	43,5	15th	9	...	...
Tanjong Malim	78,7	85,3	73,1	88,4	70,8	...	...	92	3	69	3	80	1	73	1	3,4	7,3	1,0	27,4	27,7	26,0	84	71	95	11,14	283,0	47,0	12th	14	...	...
Grik	77,2	86,4	74,5	87,8	70,0	...	...	92	2	66	2	80	2	73	3	3,6	9,8	0,7	25,7	28,2	27,7	84	62	97	4,57	116,1	39,0	4th	12	...	...
Klian Intan	74,5	81,0	72,7	83,8	69,3	...	...	89	1	68	12	80	4	74	1	2,5	5,3	1,6	24,8	26,6	24,7	88	77	92	6,15	156,3	49,4	15th	15	...	...
Kroh	75,7	30,0	69,7	82,8	69,4	...	...	87	4	66	1	77	2	74	1	3,6	5,8	1,0	24,4	25 0	23,0	83	75	95	3,26	82,9	28,5	17th	17	...	...
Tanjong Rambutan ...	...	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	11,94	303,2	58,4	5th	15	...	...
Sitiawan	81,8	84,4	75,5	88,2	72,5	...	...	91	3	70	1	85	1	74	8	5,1	5,8	0,9	27,7	29,1	28,3	79	76	96	8,88	225,6	33,5	17th	15	...	...
SELANGOR—																															
Lake Gardens, Kuala Lumpur	79,0	85,9	75,9	88,6	70,8	153,9	70,7	92	1	68	3	82	1	73	4	4,2	9,3	1,7	26,4	25,3	27,4	81	64	92	7,55	191,9	41,5	4th	17	4,94	153,20
General Hospital ...	79,7	84,9	76,4	87,2	72,5	145,1	71,3	91	1	70	4	82	2	75	2	4,5	8,8	2,2	26,6	25,1	27,0	80	65	89	6,79	172,5	34,6	12th	20	...	...
Klang	77,9	83,5	77,5	84,0	73,4	...	...	88	1	69	1	82	6	75	6	2,8	6,4	2,0	27,6	27,2	28,5	87	73	91	6,09	154,7	41,0	1st	17	...	...
Kajang	79,4	85,4	75 3	89,0	71,2	...	...	92	1	67	1	82	1	71	2	4,3	8,6	1,4	26,6	25,8	27,3	81	66	93	11,59	294,4	51,3	8th	17	...	...
Kuala Selangor	81,1	86,9	74,4	87,8	72,6	...	...	89	11	71	3	84	2	74	1	4,3	8,0	0,8	28,3	28,2	27,4	82	69	96	12,33	313,2	69,9	16th	18	...	...
Serendah	79,8	84,7	75,7	89,5	71,0	...	...	92	1	69	3	86	2	74	1	4,5	8 1	1,4	26,7	25,9	27,4	80	68	93	28,41	721,6	267,7	13th	17	...	...
Kuala Kubu	80,4	85,0	75,3	88,5	71,3	...	...	92	2	67	1	82	1	75	3	6,4	8,6	2,0	24,6	25,4	26,4	72	66	90	6,90	175,3	31,3	4th	14	...	...
Telok Datoh	...	...	...	88,5	72,3	...	...	91	3	70	3	84	1	74	4	...	...	...	...	...	..	..	...	...	11,08	281,4	50,8	4th	17	...	...
NEGRI SEMBILAN—																															
Seremban	81,5	84,5	75,6	87,5	71,7	...	71,1	91	1	69	2	84	2	73	6	4,9	6,8	1,2	27,7	27,7	27,9	79	73	94	8,91	226 4	43,9	15th	19	...	...
Kuala Pilah	79,0	82,4	74,5	85,2	69,8	...	...	89	3	67	2	81	1	73	1	3,9	6,0	1,4	26,9	26,9	26,6	82	75	93	8,13	206,6	47,2	11th	14	...	...
Tampin	79,7	84,0	75,7	87,8	69,9	...	...	91	1	64	1	84	1	73	4	4,1	7,0	1,6	27,2	26,9	27,4	82	71	92	5,73	145,6	29,2	16th	16	...	...
Port Dickson ...	80,6	83,5	79,9	86,0	73,8	154,5	...	92	1	72	4	84	2	75	8	4,5	6,3	3,3	27,4	27 4	28 8	80	74	86	11,68	296,6	64,0	12th	14	...	...
Jelebu	77,3	81,7	76,3	86 1	71,4	...	...	89	3	67	1	83	2	74	1	3,1	5,2	2,1	26,5	27,4	27,1	86	78	90	8,49	215,7	58,0	4th	18	...	...
PAHANG—																															
Kuala Lipis	76,9	83,5	74,6	86,7	71,8	...	...	91	1	70	2	82	3	73	3	2,5	7,1	1,2	27,0	26,2	25,9	88	71	94	16,15	410,1	50,0	16th	24	...	...
Raub	76,5	81,9	73,7	83,7	70,8	144,5	70,3	87	4	69	5	81	1	72	8	3,1	7,0	1,0	25,8	25,0	26 5	86	71	95	11·25	285,8	72,4	4th	22	...	...
Bentong	76,6	83,4	74,9	87,8	71,0	...	...	91	3	68	3	80	1	73	5	2,1	6,5	1,2	27,4	27,0	27,2	90	73	94	12,64	321,1	50,8	4th	28	...	...
Pekan	79,3	80,6	76,7	83,0	73,5	...	...	87	2	70	2	76	1	78	1	3,2	4,0	1,9	28,3	28,3	27,9	85	83	91	28,86	733,0	244,4	10th	21	...	...
Kuantan	78,8	81,6	75,6	85,3	72,5	...	...	89	1	70	4	82	3	75	3	3,9	5,8	1,6	26,7	26,4	27,3	82	76	92	21,20	538,4	183,4	10th	25	...	...
Sungei Lembing ...	..	...	...	83,6	71,9	...	..	89	3	67	1	75	1	77	1	...	...	...	...	..	...	..	...	..	19,35	491,5	108,0	9th	27	...	...
Cameron's H'lands (Tanah Rata)	61,9	67,7	61,7	69,5	57,0	133,9	55,1	74	2	47	1	66	2	61	2	1,5	4,1	1,1	17,0	17,9	17 3	92	80	94	6,35	161,3	62,7	4th	21	3,11	96,55
" " (Rhodn. Hill)	60,6	65,6	...	68,2	57,3	131,1	56,2	72	4	54	1	63	2	59	4	1,3	3,0	...	16,4	17,6	...	93	85	...	6,18	157,0	56,0	4th	22	3,13	97,00
Fraser's Hill	62,5	67,4	63,2	69,0	60,7	128,2	60,3	73	6	58	1	63	1	62	9	0,3	2,5	0,4	18,7	19,4	19,1	98	87	98	14,61	371,1	62,7	4th	26	2,43	75,25

RAINFALL STATIONS

Perak. —	Total. In.	Total. m.m.	Most in a day. m.m.	Date.	No. of rainfall days.
Kuala Kurau	4,79	121,8	59,1	3rd	7
The Cottage	16,61	421,9	120,7	5th	18
Maxwell's Hill	14,48	367,8	102,4	4th	20
P. Tanjong Bagan Datoh	5,42	137,7	30,6	29th	18
Sungkai	7,89	200,5	43,0	5th	19

Selangor. —	Total. In.	Total. m.m.	Most in a day. m.m.	Date.	No. of rainfall days.
Sabak Pernam	8,14	206,9	35,3	12th	13
Dist. Hosp., K.L.	6,63	168,5	47,1	5th	16
Prisons, K.L.					

Negri Sembilan. —	Total. In.	Total. m.m.	Most in a day. m.m.	Date.	No. of rainfall days.
Mantin	3,68	92,3	16,4	17th	12

Pahang. —	Total. In.	Total. m.m.	Most in a day. m.m.	Date.	No. of rainfall days.
Temerloh	11 89	302,0	45,7	27th	15
K. Tembeling	3,72	94,4	17,4	4th	23
Rompin	20,35	517,0	105,8	10th	16

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; and the Malay States Information Agency, 88, Cannon Street, E.C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

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Vols. I--IV	(1913-16) VIII & IX (1920-21)		price	$5.00 per volume.
Vol. V	(1917)	Nos. 1, 2, 3, 5 & 6	,,	2.50 per set.
,, VII	(1919)	,, 2--6	,,	4.50 ,,

(Vol. VI is out of print.)

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

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,, XI	(1923)	Price $5.00 per volume or 50 cents per single number.
,, XII	(1924)	,, ,, ,, ,,

Back numbers of Vols. I--X will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co.

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher.
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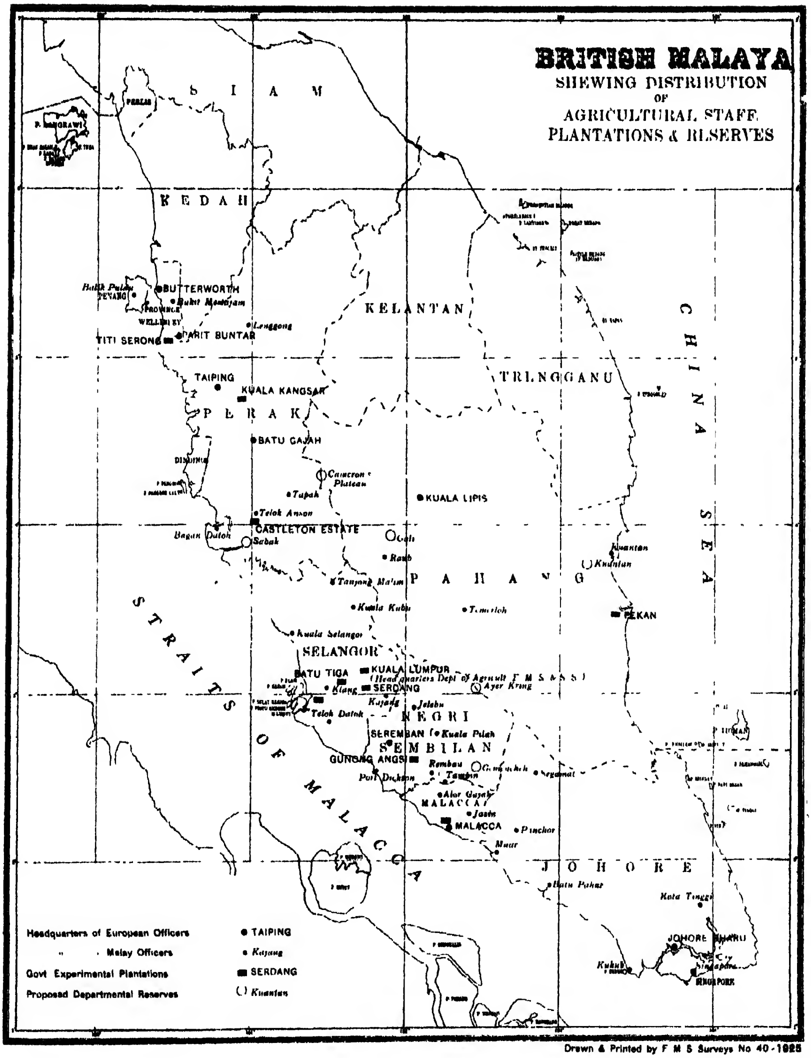

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